The NATIONAL GEOGRAPHIC MAGAZINE

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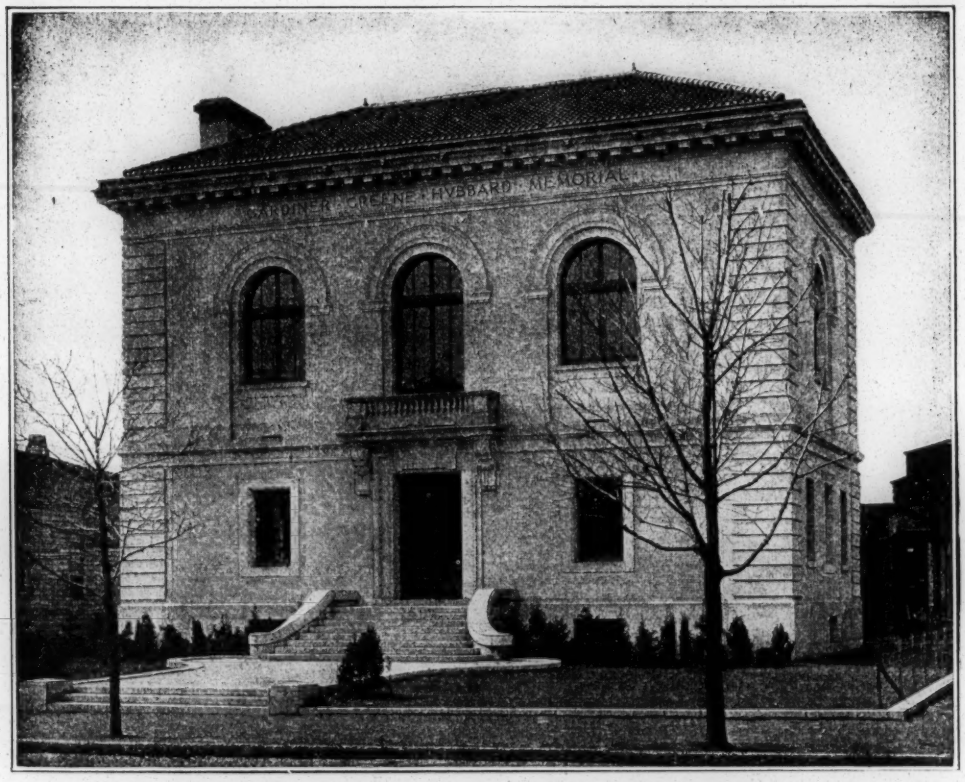

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VOL. XVII, No. 5 WASHINGTON MAY, 1906

THE NATIONAL GEOGRAPHIC MAGAZINE

THE NEW BRITISH EMPIRE OF THE SUDAN*

BY HERBERT L. BRIDGMAN

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GREAT BRITAIN today dominates the whole of Africa and has its future within her control as surely and as firmly as that of India. Germany in the northwest and southeast; France, Belgium, and Portugal around the margin of the Atlantic and the Indian oceans, may have their "holdings" and their territorial jurisdiction; but the spinal column, the Cape-to-Cairo trunk line through the continent from north to south, is wholly and irrevocably English, and whenever it becomes necessary to make this fact emphatic and forcible, then the mastery of the situation, the advantage of the position, will be demonstrated. In the meantime Great Britain, applying the same principles which have made her the great colonial power of the world, goes on developing the industrial and commercial resources of the countries which have fallen under her influence, establishing law and order, schools, even higher institutions of learning, and pouring in upon the places which have for centuries been shrouded in darkness the light of modern civilization. The fact is that modern methods have accelerated civilization at large almost as rapidly as in detail; with steam and electricity in the service, the spread of the institutions of the civilized world is immeasurably more rapid than a century ago, and what then would have taken a generation to accomplish is now effected in a few years.

Since the recapture of Khartum and the conquest of Egyptian Sudan barely seven years have passed, but peace, plenty, and prosperity reign everywhere. Happiness and content are written on every countenance; life is as safe as in England or in New York, and the future, material and moral, seems normal, wholesome, and auspicious. "Sudan needs only population and capital," said a prosperous Greek merchant with whom I became well acquainted at Khartum, "and both are coming to it in ample measure." On one plantation near Berber, the other day one hundred and twenty children, the eldest less than six years of age, all children of the men and women employed on the place, were photographed, and the streets and bazaars of Omdurman, the commercial capital, as well as those of every working station along the White Nile, give cumulative proof of the dawn of the new era of good times.

* An address to the National Geographic Society, February 16, 1906. This is the second of a series of articles on Africa arranged for the NATIONAL GEOGRAPHIC MAGAZINE during 1906. The first in the series, "Morocco," by Mr Ion Perdicaris, appeared in the March number.

THE SIZE OF THE SUDAN

The true significance of Great Britain's peaceful conquest might more readily be appreciated if the size of the Sudan were considered. True, its boundaries are not altogether determinate and irrevocable; one or two rebellious sheikhs on the west are awaiting the return of reason or the arrival of a punitive expedition—the option is largely theirs. Questions of administration have pushed the northern boundary to Shellal, at the head of the first or lowest cataract of the Nile, but in a general way the Sudan extends from the Red Sea 20 degrees of longitude west to the Sahara, and from Egypt 20 south to the Equator. Various exceptions and re-entering angles should be cut in this parallelogram, but it is roughly accurate and will serve for the purposes of comparison.

Reduced to the simplest terms of American geography, it may be said that if Khartum, the Sudan capital, were placed on St Louis, the northern boundary would fall near Saint Paul and Minneapolis; the southern would be about on the parallel of Memphis, Tennessee, while its Red Sea port, Suakin, and its yet to be fixed Saharan outpost would find counterparts in Cincinnati, Ohio, and Denver, Colorado, respectively. When it comes to comparison of areas, only the largest of our American states has any show; a dozen of the smaller Atlantic coast states could be readily accommodated in the Sudan.

Of course, the resources of this inland empire are as yet hardly guessed at. It is certain that as an agricultural field it is in some parts along the thousands of miles of the Nile valley peerless, inexhaustible. Cotton, wheat, and cane are staple and give every promise of prolific crops, while further afield there are all the indications of excellent stock ranges and cattle-raising. Rubber and many of the tropical fruits promise in the Nile districts to afford satisfactory results, while the specialties which have composed the greater part of the Sudan commerce from the dawn of recorded time—ivory, gum, and ostrich feathers—all worth almost their weight in gold, and which can bear the cost of transportation, are absolutely without fear of competition.

THE POLITICAL SITUATION

Without entering on the complex and unique relations and functions of the English chief official in the Nile Valley, it may be worth while to tell you an anecdote of an actual incident which will perhaps make the situation fairly clear to the average republican and undiplomatic understanding. Upon one occasion negotiations had progressed to a point where Lord Cromer required, as a matter of form, the Khedive's signature to a state paper. Waiting upon him for that purpose in the khedivial palace, Lord Cromer was more surprised than annoyed to observe a certain querulousness and quibbling over small matters in the young monarch, which betokened a rather critical, not to say rebellious, mood. Finally screwing his courage to the sticking point and giving rather free rein to his imagination:

"But what if I don't choose to sign?"

"Then, Your Highness, Ceylon," blandly observed Lord Cromer.

"Ceylon?" asked the young monarch, as he recalled Arabi Pasha and his exile.

"Yes," replied the imperturbable Englishman.

"But suppose I ignore your threat and still refuse to sign," persisted the Egyptian.

"Perhaps Your Highness will do me the favor to look from this window a moment," proposed the viceroy.

The Khedive rose, crossed the room, and side by side with Lord Cromer looked down on a full battalion of Highlanders, drawn up, under arms, in the palace yard below. Not a word was said, but he resumed his seat and affixed his autograph with no further remark on that or any subsequent occasion.

Like the fabled Phœnix of ancient Lydia, neighbor of the Sudan, Khartum has risen from its ashes, from its years of war and desolation, and it is difficult to

realize that only seven years ago this enchanting spot was little more than a barren and wind-swept waste, the miserable home of a few wretched faithful, who persisted, despite the Khalifa's purpose to obliterate the place. A completely new city has been laid out by the British engineers, and much of the permanent improvements, street and sidewalk construction, paving and curbing on the best modern lines, has already been completed. Building is everywhere going on; the most important public offices are finished and occupied, and the town has an air of modern enterprise and development, combined with substantial permanence, which it would be difficult to parallel elsewhere in the world. Every public structure of any importance is of kiln-burned brick; most of the shops and warehouses are also of the same material. Some of the dwellings and smaller buildings are of native sun-dried brick made from the soil, which is very satisfactory for many purposes, while wood, both on account of cost and the climate, is altogether out of the question. The new Mohammedan mosque, in the most commanding and central square of the city, is of a light "Ohio" sandstone and of much architectural merit.

KHARTUM RESEMBLES WASHINGTON IN PLAN

The ground plan, if this is the word, of Khartum is altogether new and original and reminds an American at once of that of the city of Washington. Long diagonals cross the streets and avenues, intersecting at right angles, and frequent open spaces or "circles" carry the resemblance into still closer detail. The army engineers who planned the town will tell you honestly that military considerations guided them, and that a very few field pieces can command the city, which is obviously true; yet we never think of these things in our merited gratitude to L'Enfant for his admirable design of our National Capital, more than a century ago. The two principal avenues, traversing the town from end to end, are Sirdar and Khedive, while many of the streets and squares, though in constant use, are as yet without names.

In its treatment of the river front, however, Khartum, the latest city, has given an example to all the world, and adopted a plan which assures beauty and blessing for all time. On the bank of the Blue Nile, here fully fifty or sixty feet above the water, a broad avenue has been laid out, probably 100 feet in the clear, and upon this no trespass of business structures or commercial appropriation will be permitted. It is a modified Riverside drive in the heart of Africa, and will surely grow more and more beautiful as the years go on. For some distance in front of the Sirdar's palace a river wall, a splendid piece of solid stone masonry, has been completed, and ultimately will be continued along the entire water front, thus insuring protection against the destruction of the bank by the floods of "high" Nile. Occasional stages, at convenient points, will permit the landing of passengers and freight, and with rare good judgment the "sakiehs," or water wheels, raising the water for irrigation, have been undisturbed, and the patient bullocks, prodded by the lazy boy, who rides the while, still pursue their weary round from sun to sun, while the clumsy machine, unchanged for thousands of years, gives out its plaintive creak, like the last wail of an utterly weary and exhausted soul.

KHARTUM'S STRATEGIC POSITION

The future of Khartum is even now in its infancy clearly foreshadowed. Reaching the Nile and the Red Sea by rail and Abyssinia and Uganda and the Belgian Congo by water, there is no doubt of its commercial supremacy, and that it must soon become, if not the largest city of Africa, as some of its admirers predict, the political center and the business metropolis. None of our American cities, not even Chicago, at the head of the lakes, has the advantages of location which Khartum possesses—advantages which are sure to grow more and more

important and determining as interior transportation improves and steam displaces animal traction and human porterage. In its municipal functions the future divisions of Khartum are also even now clearly outlined. The administrative headquarters, military and civil, will inevitably continue where they now are, in the city proper, the residence of the governor general and commander-in-chief and of all the principal subordinates and heads of departments; the railway terminal, and particularly the freight depot and dock yard, will remain on the opposite side of the river, at Halfaya, or Khartum North, insuring great convenience in handling and transshipment by water, both receiving and dispatching, while the vast native population, with its wholesale and retail markets and all its myriad activities, will be accommodated as now, at Omdurman, the Mahdi's city, seven miles away and just below the junction of the Blue and White Niles. Here will center the traffic of the western and southern Sudan, for it now holds, in spite of every effort to dislodge it, the gum market of the world; and here also must continue the headquarters of the retail trade of the province. Within the Khartum military district as it is now constituted, and comprising the three above named centers, are probably 70,000 inhabitants, of whom more than half live in Omdurman, possibly a tenth in Khartum proper, the latter including all told not over 300 British army officers and civilians, the remainder occupying Khartum North and the environs between the two Niles. Do you wonder, after these figures and after what has happened, that the British flag everywhere fronts the Egyptian, and that nearly all the field officers of the Sudan regiments hold also commissions in the King's service? Even now they are talking of the time, soon to come, when there will be but one flag, and there's no doubt which.

GORDON MEMORIAL COLLEGE

No sketch of Khartum, "the Phœnix City," would be in any degree complete or adequate without a description of Gordon Memorial College, now about in the middle of the second year of practical work, and which represents the very latest and closest application of educational theories put to practice. Some idea of the part which Gordon College is expected to play in the regeneration of the Sudan may be gathered from the fact that King Edward is its patron, Lord Kitchener of Khartum its president, and Lord Cromer, the Sirdar, Sir Ernest Cassel, and Lord Revelstoke, and men like them, among its trustees. Director and at the head of its teaching force is James Currie, a Scotchman with the courage of his convictions, who has tackled his job with that sturdy common sense which characterizes his canny race, and who has but one motto, "Success."

Arabs are taught in Arabic, English being optional, and no attempt is made to interfere with the Mohammedan religion. Classes meet on the Christian Sabbath as on other days, and the teachers, many of them natives, are not disturbed in matters of conscience. The chief effort at the present time is to train a body of young men who will be able to exercise among their own people the function of minor civil magistrates, according to European standards and ideas, and to this end about 150 young sheiks—many from the desert and personally selected by Sir Slatin Pasha, whose acquaintance, more thorough and accurate than that of any other man, was gained by ten years of peril and terror under El Mahdi and El Khalifa—are now under instruction with most encouraging promise.

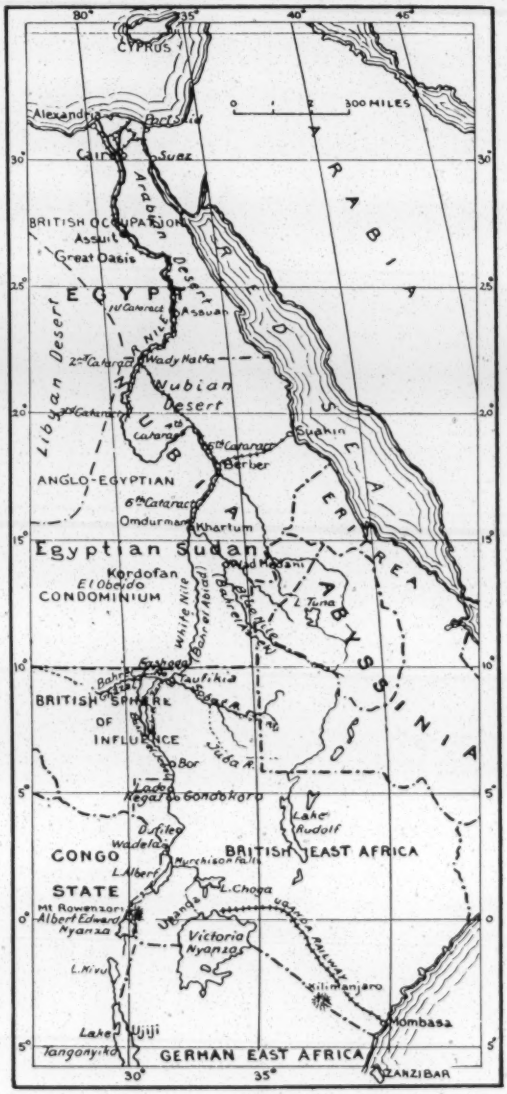
EDUCATING THE ARABS AS MECHANICS

There is also a manual training school in mechanic arts and a research laboratory bearing the name of its founder, Henry S. Wellcome, of London. Forty young men are now being instructed in the training school, and unless one could see and handle their work—tools wrought through all the processes, smelting, forging, and finishing, from the ore; pumps in operation, built and installed with electric motors and lights; cotton

gins set up and in successful operation—it would be difficult to believe that in two years so much could be made of the wild Arab of the desert. But here the explanation is not difficult: mechanics are in much greater demand than supply; steady jobs in the government shops and dock yards are ready for all qualified; the Arab is as keen for money as any man who lives, even in Wall street.

The Wellcome laboratories have already won recognition from the scientific world for the value and thoroughness of their work, and the first annual report, taking up the actual question of the Sudan, is already standard and classic; for the Sudan field, so far as exact scientific knowledge is concerned, is almost untouched; and here the investigators, having a free hand, take up the pernicious insects (particularly the deadly fever-spreading mosquito), the blight and diseases of plants, the ills that human flesh is heir to, and all the other manifold matters of imperative practical importance, with a zeal and a thoroughness surpassed in no other laboratory work in the world. Far up the White Nile, living on a "felucca," isolated from the world, with native servants his only companions, we found Dr Grenville Neaves, conducting under the auspices of the Wellcome laboratory hand-to-hand researches into the dread sleeping sickness which has decimated districts of the lower Congo and which will be resisted in the Sudan by every expedient known to science that exact knowledge can suggest.

Gordon College has now estate and endowments of about half a million dollars, one-fourth of which is invested in one large brick building of the Gothic order, where its classes and laboratory work are carried on, and its pathological and biological museum, under a young American graduate of the University of Pennsylvania, is located; and its classes of young Arab lads, instructed by teachers of their own faith and race, are a picturesque and suggestive sight, as one walks down the long corridors, catching glimpses of the work through the open door.



Map

"Pay as you go" is, moreover, the motto of Gordon, and, much as pupils are desired and greatly as the institution and its work are needed for the public welfare, no tuition is free. Every student is taught "that what is worth having is worth paying for." The fee averages only $10 a year. Next year a boarding school, in which the charge will not exceed $50 per year, is hoped for.

No radical or reactionary attempt is made to interfere with social customs or old, familiar usages. For example, if the young Arabs wish to convey food to their mouths with their fingers, like their ancestors for generations and their families today, they are permitted, but they are taught that the washing of hands before and after eating is imperative.

THE UNION OF THE TWO NILES

The union of the two Niles, or, rather, the refusal of the two currents to unite, never fails to attract attention and is a phenomenon which has had many explanations. For miles the waters of the two streams flow on distinct and repellent, as though a physical barrier separated them, and one can trace the division as far to the north as one can see—the Blue Nile, with its somber, almost black waters, hugging the eastern bank and taking about a third of the width of the stream, while the turbid White, laden with the light-colored soil 2,000 miles to the south, keeps steadily on its way, as though the new neighbor were unworthy of notice.

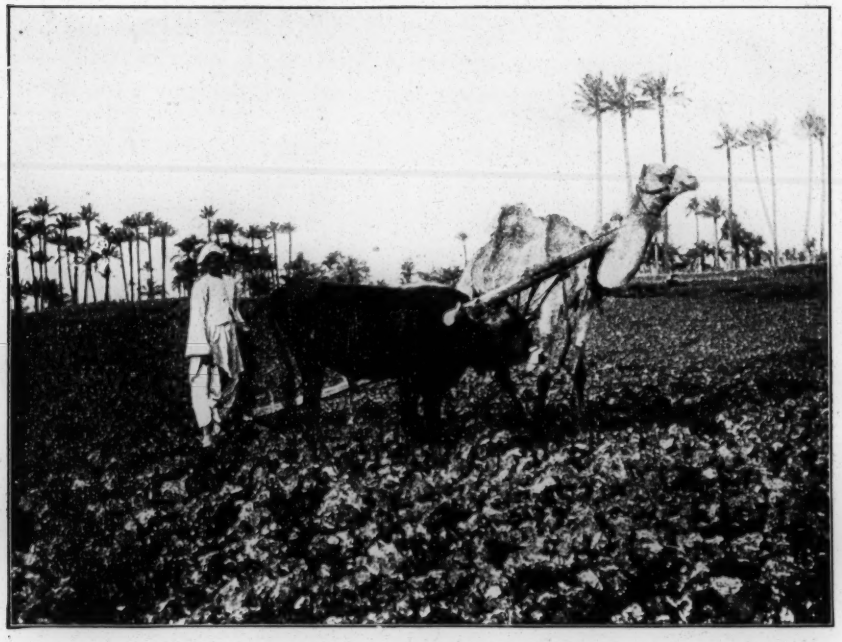
Omdurman may be reached in two or three ways from Khartum, but the best is by the little two-mile-and-a-half two-foot steam tram, which, starting from the Mosque square in the heart of the town, winds its way through the market gardens, melon and durra patches, whose owners, with their families, are sunning themselves against the walls of their Nile mud houses in the windy and chilly morning, to the ferry landing, whence a steamer with the inevitable barge soon puts you on the other side.

THE MARKETS OF OMDURMAN

The gum market at Omdurman is the greatest of its kind in the world. Here, exposed to the full rays of the morning sun and spread out on acres of mats, are heaped the treasures of the trees of the Kordofan desert, brought hundreds of miles on the backs of camels. In one corner of the great inclosure, sheltered by an awning of mats, groups of kneeling women are sorting the gum, picking it over, rejecting all foreign matter, gathering pieces of like size and quality that it may be more readily graded, and using nothing but eyes and hands for the process. Here is the raw material which makes the gum as applied in the arts and sciences in a thousand different ways—on every envelope, postage stamp, in confectionery, etc.

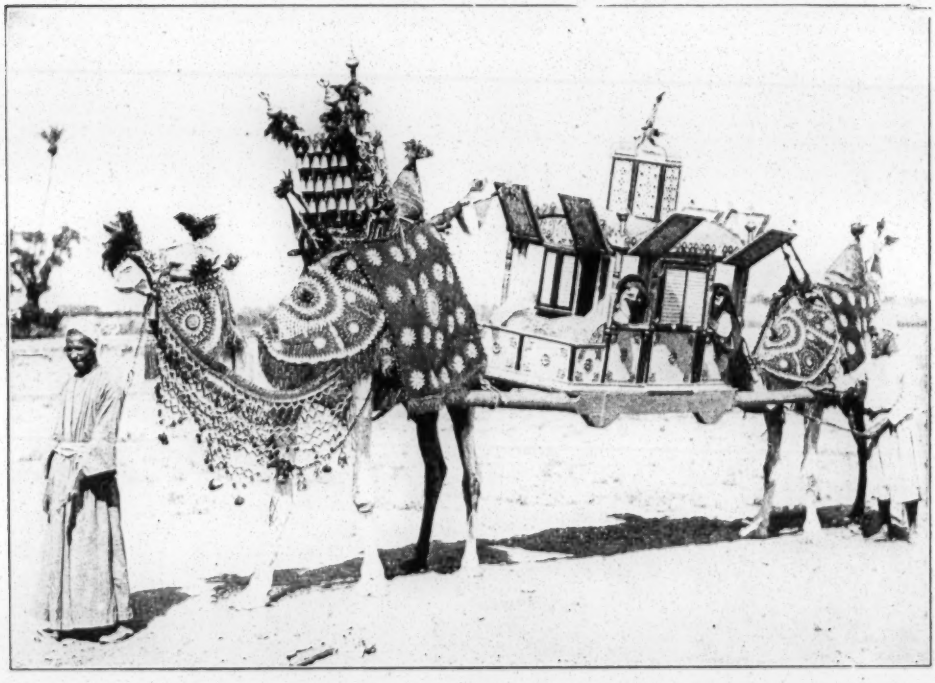
The silversmiths are among the most interesting artisans of Omdurman, and to them practically the whole of one street is given. A charcoal fire as big as a half bushel, half buried in the ground and blown by a crude, antiquated bellows (one was nothing more nor less than an old canvas bag with a hole at one corner, which an Arab boy regularly lifted and lowered, and with good effect, too), an anvil set in the earth, and a few small hammers constitute the workman's entire stock of tools, and with these he turns out very presentable wrist and ankle ornaments, bracelets, and finger rings, and other articles which touch the barbaric fancy of the Sudanese women. Little originality or variety, however, is expressed in the designs, and the workmanship, while creditable, considering the tools with which it is done, would not be accepted in the shops of London or New York. The Omdurman smiths are, however, fully alive to the value of their wares, and hunters of bargains are sure to be disappointed. They know the worth of the raw material in every article they fashion, and, remembering this, have a bottom figure which is immovable.

Still another interesting business center of the great Sudanese metropolis is the cattle and camel market—an extensive corral filled with live stock, except horses, which are the exclusive possession of the British officers. As we stood on its walls, surveying the busy and picturesque scene, the Arab dealers and drivers, in their white turbans and long blue gowns, moving to and fro among the animals, to the south a long string of a hundred or more gum-laden camels from Dongola crossed the near horizon, reflected in the glaring



From Clarence J. Johnston, U. S. Department of Agriculture

Plowing Land which has been Baked by the Sun



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Egyptian Bride going in State to Her New Home

1. Dahabeahs of the Nile
2. Avenue of the Sphinxes, Luxor
3. Street scene, Omdurman
4. Temple of Isis, Philæ

mirage of noonday as if "the ships of the desert" were actually sailing on the glassy surface of a vast inland sea.

THE BERBER-SUAKIN RAILWAY

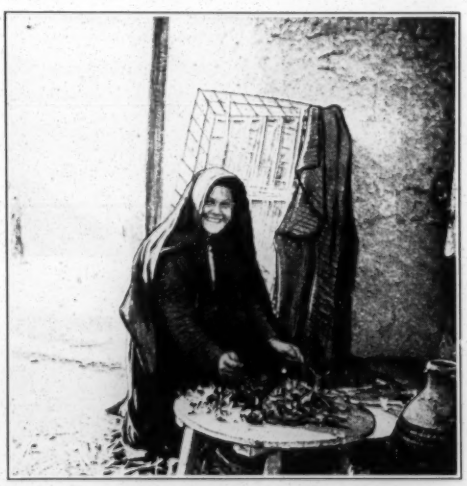
This distant region has been brought within three or four weeks of New York by the completion of the Suakin-Berber route, the "old line" from Egypt to the Sudan. For centuries camel trains and traffic went in and out this way, and it was along this route, not less than up the Nile, that Gordon looked in vain for his relief. By the completion of this comparatively short section of 250 miles from Suakin to Damen, the actual point of junction, Khartum and the Sudan have secured their own port on the Red Sea, with direct access thence to all the world, and the problem for transportation for interior Africa is solved. Today a passenger may travel from New York to Gondokoro, in Uganda, all the way by water, except for the 270 miles from Suakin to Khartum; and then, if he has a mind to walk 120 miles farther to Nimule, he may sail into the waters of Lake Albert, the very heart of the continent and the source of the Nile.

It is impossible to exaggerate the commercial importance to the Sudan of the new line. Its opening has been hailed with eagerness as the beginning of a new era, not so much because it will reduce the time of passengers and mails from home as because it will solve the fuel question and permit Welsh coal to be laid down at living prices in Khartum—a condition which will at once affect the whole question of interior transportation. All classes of freight will feel the effects of the change. Politically also the consequences will be momentous, though just how soon they become effective is a matter for Lord Cromer and his associates. The new line will minimize, if not wholly eliminate, the Nile as the way to the Sudan, and will accelerate that substantial autonomy and independence of the provinces which is so much to be desired.

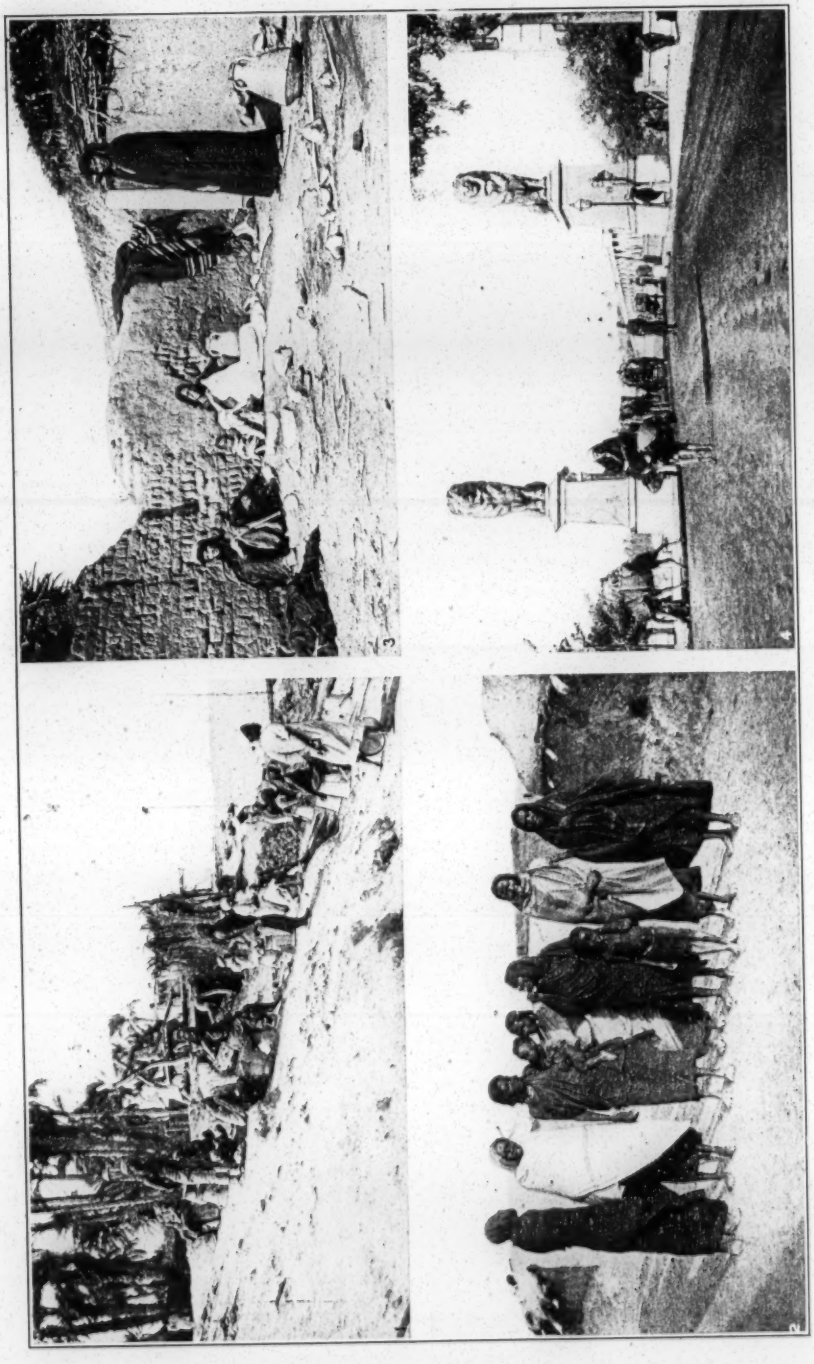
A Water-carrier, Khartum

TRAVELING UP THE NILE FROM KHARTUM

Like ancient Gaul, the White Nile and its country readily divides itself into three parts. The first, longer and larger



A Fruit Seller, Omdurman



1. Bank of the Blue Nile below Khartum
2. Arab Suburbs, Khartum
3. Bisharin Arabs, Omdurman
4. Kasr el Nil Bridge, Cairo

1. Arrival of the Kodofan Camel Train, Omdurman
2. Grand Hotel, Khartum
3. Watching the Polo Players, Omdurman
4. Between Blue and White Niles, Khartum

than both the other two, from Khartum nearly 600 miles to Lake No, the junction of the Bahr-el-Ghazal and Bahr-el-Jebel, is the arable and pastoral land, the home of the Shillook; then come 300 miles of swamps and sudd, and beyond is the solid earth again, the real tropical jungle, the haunt of the Dinkas, elephants and lions, until between vertical banks the voyage comes to an end under the bluffs of Gondokoro. Of course, in this thousand miles there's a good deal to see, and ample time is allowed in which to see it. To the first stop, for example, El Duem, is 110 miles, and the running time is 31 hours.

All the way to El Duem the Nile broadens out into a series of lakes much

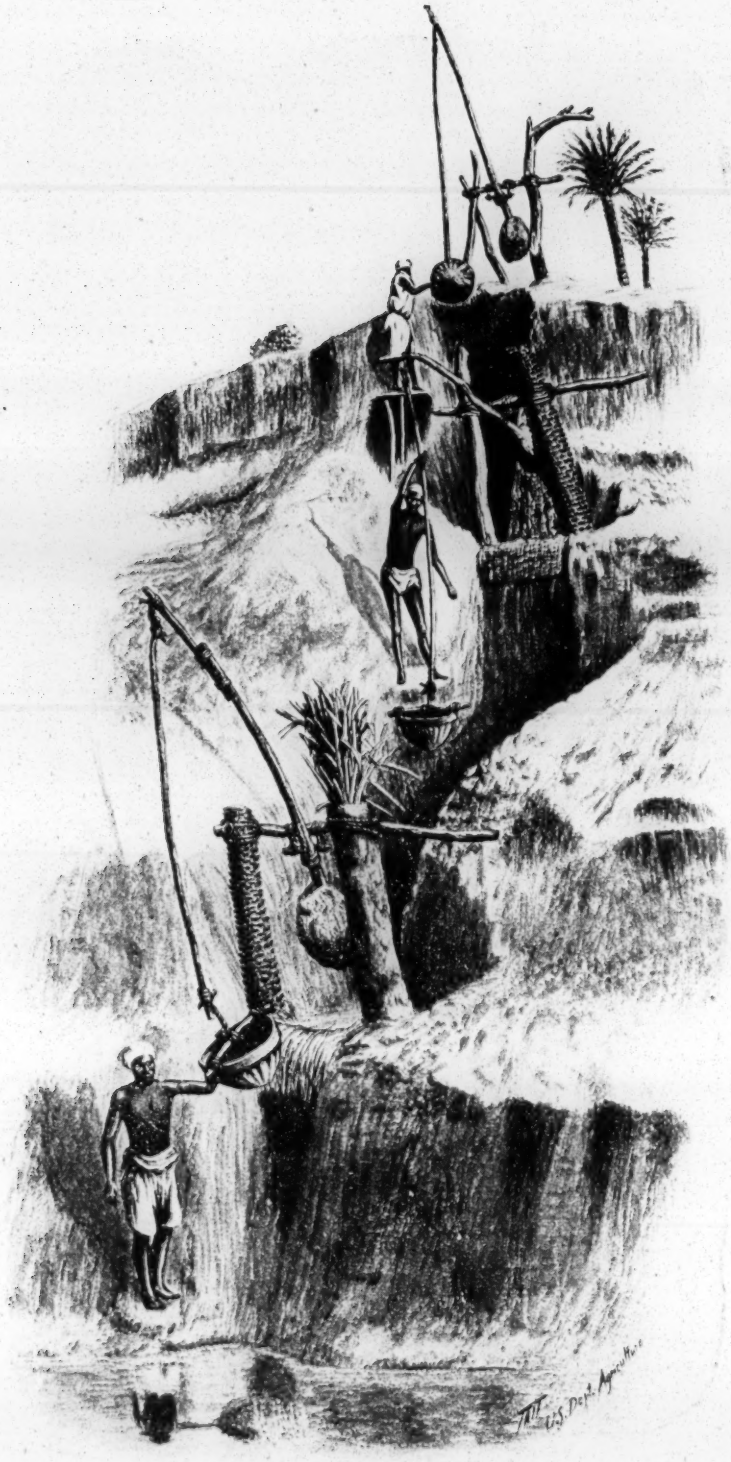
Girls at Omdurman

more expansive than below Omdurman, dangerously shoal in some places, and occasionally showing low islands, not more than a foot or two above water at their highest point, which are eagerly seized on and subjected to cultivation by these riverain Arabs, who seem possessed with a genuine and chronic "land hunger."

For the first hundred miles the desert on either side and the high profile of mountain ranges beyond, as on the Egyptian Nile, is plainly visible, the foreground being filled, wherever a foothold can be found, with green fields, solid with dense bush vegetation, while the *shadoofs* or swinging buckets, with which irrigation is performed as it has been for thousands of years, are numerous, many being absolutely new and working for the first season.

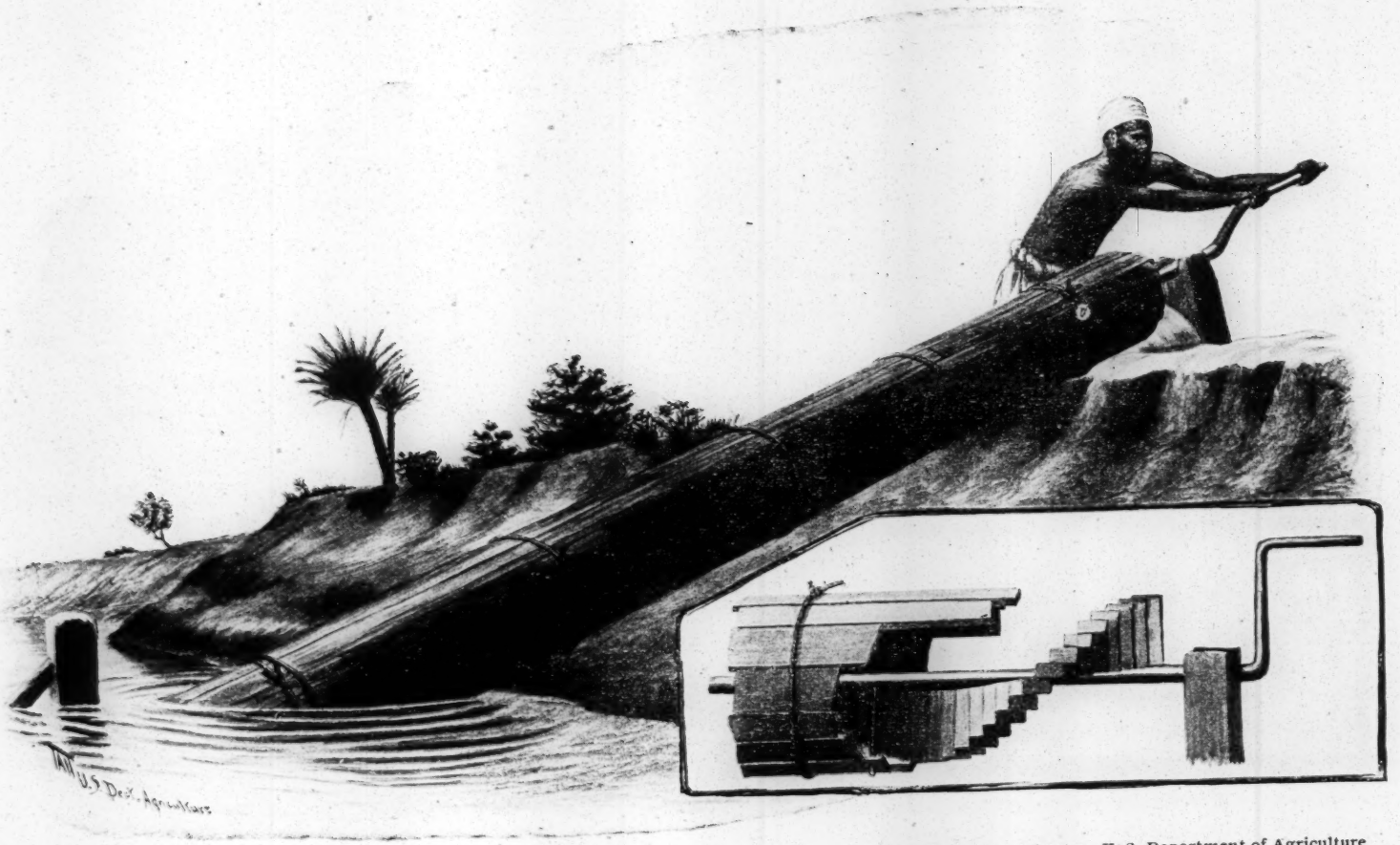
El Duem (in English, "The Two Camps") is a town with a good deal of history already made, and, if signs do not fail, likely to make a good deal more of a better sort in the early future. Port of Kordofan and its great gum trade, was the Mahdi's base of operations more than twenty years ago, when he set out on his crusade which was to end at Mecca and which devasted his own country, and was the first rallying place of the Khalifa, years later, after the rout and panic of Kerreri. It has been selected as the point where the new railroad from Omdurman is to turn off to the westward for El Obeid, the Kordofan capital, and its position must insure to it the importance which always belongs to towns commanding both land and water transportation. A stroll through the town shows that it is much like others of the Arabs. Low Nile-mud one-story houses line the narrow streets, which, however, boast a few kerosene lamps and wooden lamp posts at the prominent corners, and further evidence of modern improvements is given by the policeman who, laying vigorously about himself with a whip, charges a crowd of a hundred ragged and dirty urchins crowding around the English ladies and blocking their way so that progress is almost impossible. In the main street, sitting on the ground, a young Arab operates an American sewing machine; empty Standard Oil cans, now used instead of water jars, and a cheap iron safe or two are all evidence that even in this remote and interior point something of the great outside world has begun to filter.

By the third day the Nile begins very sensibly to narrow and the character of the country to change. Cultivated fields disappear, the mud villages grow fewer and far between, and the verge of the boundless, illimitable forest is seen to be not far away. From the deck of the steamer, what is called the forest looks more like a vast orchard of civilized trees



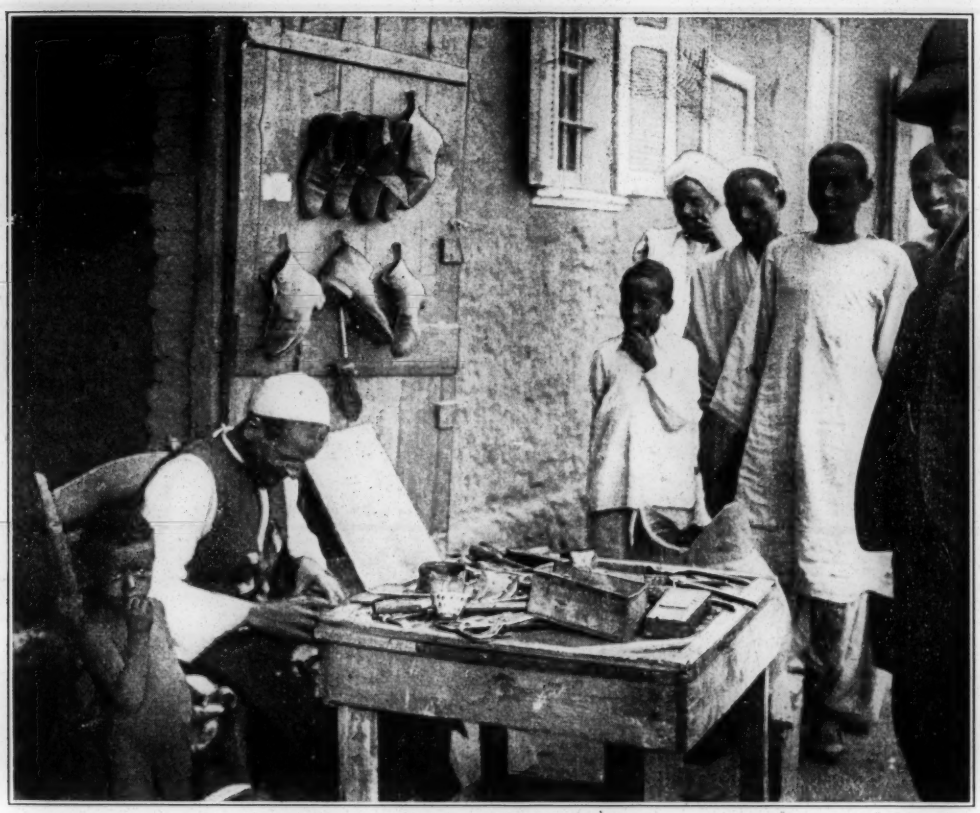
From Clarence J. Johnston, U. S. Department of Agriculture

Raising Water from the Nile by Means of the Shadoof



From Clarence J. Johnston, U. S. Department of Agriculture

Raising Water from the Nile by Means of the Archimedean Screw ; interior construction at right

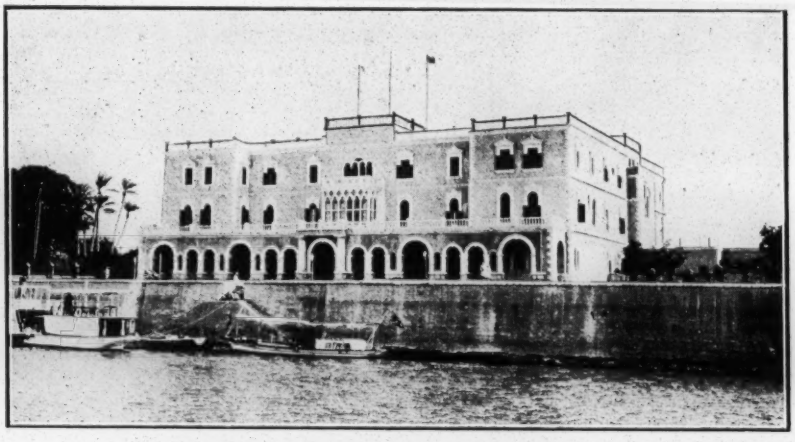


A Cobbler on the Street, Khartum

of moderate height with spreading leafy tops and to a great degree entirely free from undergrowth. The utter absence of every representative of our fir, spruce, cedar, or balsam also conveys an unusual impression. While the African forests contain an abundance of trees always in green foliage and the multi-colored tints of our autumn are never known, there is not a solitary example of the beautiful "evergreen" which adorns every Adirondack slope and flourishes, dwarfed and stunted, to the farthest Labrador. Wooding stations, each very much like those which have gone before, fill the time, but do not break the monotony, until Fashoda, after we have been at sea almost a week, is reached. By this time we are in the heart of the Shillook country, and the Arabs and their little veneer and fringe of European civilization seem as far away as Paris or Madison Square.

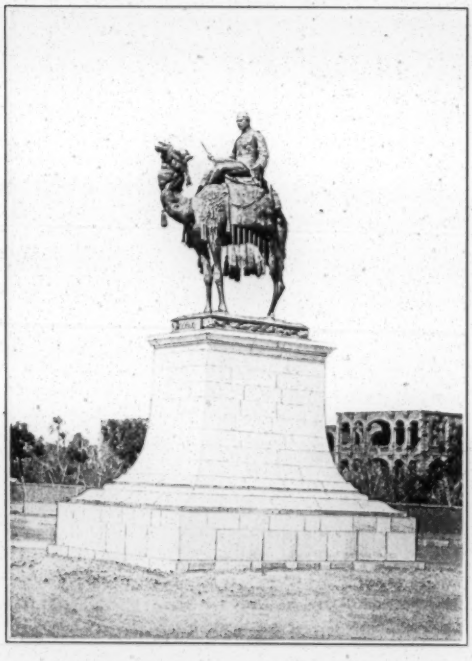
THE SHILLOOKS

The Shillook, tall, lithe, and usually wearing only a string of beads, frequently not even that, is a true child of nature. With head plastered with red mud and body with wood ashes, he toys with his murderous spear, surveying the newcomer, and one is inclined to treat him with every outward appearance of respect. Shillooks are plentiful long before reaching Fashoda; but this is their capital, and about a mile south of the port is a large collection of their tukhls, or houses, among which the king makes his



Palace of the Sirdar, Khartum

headquarters when he receives from his followers the taxes he hands over to the British commander. The Shillook further enhances his own dignity and appearance of indifference by standing on one leg while the sole of the unused foot is pointed at right angles above the knee of the leg in service, the two describing almost exactly a figure 4. Braced by his long spear, the Shillook will stand for hours in this position, and no power on earth apparently—other than that of the almighty dollar in almost any form—is sufficient to induce him to unfold and move. Much difference of opinion exists as to the industrial value of the Shillook. The officers say that he is too lazy to work, to talk, actually even to smoke, preferring to hand the pipe to a wife or female to keep it alight, that an occasional puff may be enjoyed, while the missionaries speak with hope of encouraging results.



Gordon Statue, Khartum

Cattle are the currency and cattle-raising the great industry of the Shillooks, and their herds of thousands range over the level luxurious valleys, almost concealed by the tall grass. The stock are a worthy lot, all colors and sizes, and evidently a skilled American breeder could ask no more inviting field. Shillooks never kill cattle for any purpose whatsoever, though those which die a natural death are eaten. They are used to buy wives, six or eight cows for a woman, with the privilege to the buyer of return in reasonable time if not satisfied. The American missionaries here are giving the natives valuable instruction in the

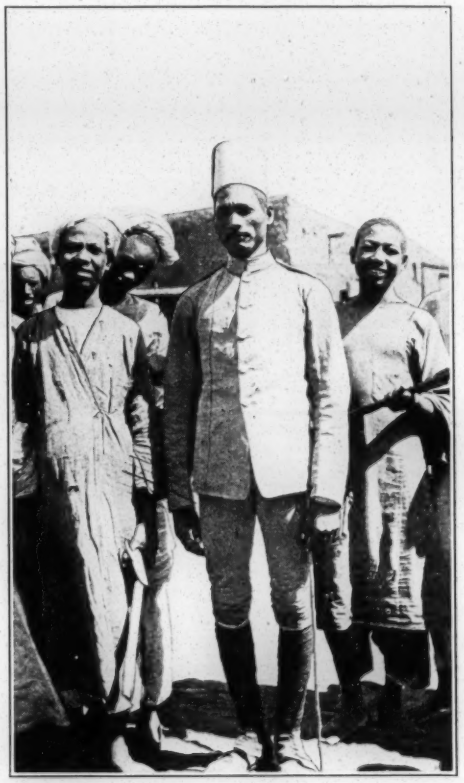
raising of cotton, using the best Egyptian cotton seed for stock, sweet potatoes and other crops adapted to the rich soil and kindly climate of the Sobat, with excellent prospects of desirable results. The Sudan has promised to allot the mission a considerable tract of land along the river.

WILD GAME OF MANY KINDS

Animal life on the White Nile is abundant, and hunters are constantly traversing it for what they call sport. "Hippos" are so numerous that after the first few days only an exceptionally large or fully exposed herd will induce the unlimbering of cameras; crocodiles are likely to be sunning themselves on every sand spit and are the only game which may be shot from the steamers without penalty. The presence of ivory tusks at the trading stations proves the proximity of elephants, and early risers may be fortunate enough to see two of the big fellows smashing along in the tall grass within easy rifle shot. Waterbuck in droves, antelopes in herds, gazelle singly but in great numbers, and monkeys too numerous to mention may all be observed in a single morning by sharp eyes, and once in a while the stately and ungainly giraffe makes his way with the rest of the animal creation to the Nile for water. All of these animals can be hunted only upon payment of heavy license, and the giraffe is absolutely protected against sportsmen on any terms—conditions which in British territory are rigidly enforced. Birds of many species familiar to the north wintering in the tropics; frequent flocks of geese flying in military formation; of ducks feeding on the aquatic plants, and a great variety of all the water fowl—cranes, herons, divers, ibis, and others—are frequent, while on the topmost branch of many a lonely tree the stately fish eagle in solitary dignity is a familiar figure. In the river also are treasures of life, as the continual succession of fishermen's huts, almost hidden among the reeds, proves. Hither the natives come and catch and cure, while the season is on, supplies for a long time—the only thing resembling work which they are known voluntarily to undertake.

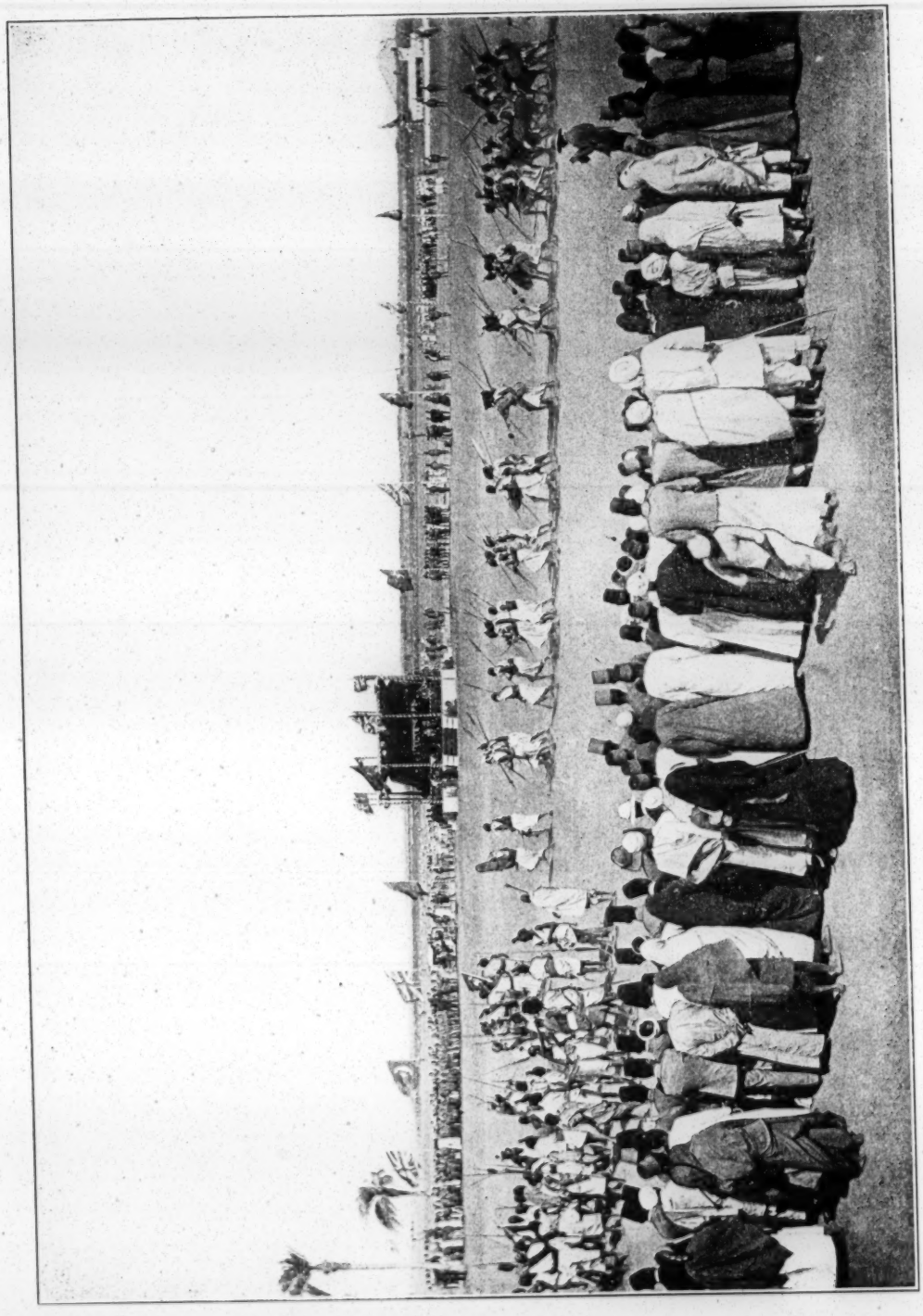
FASHODA

Fashoda has the deserved distinction of being historically by far the most interesting place on the Nile south of Khartum. Physical circumstances have much

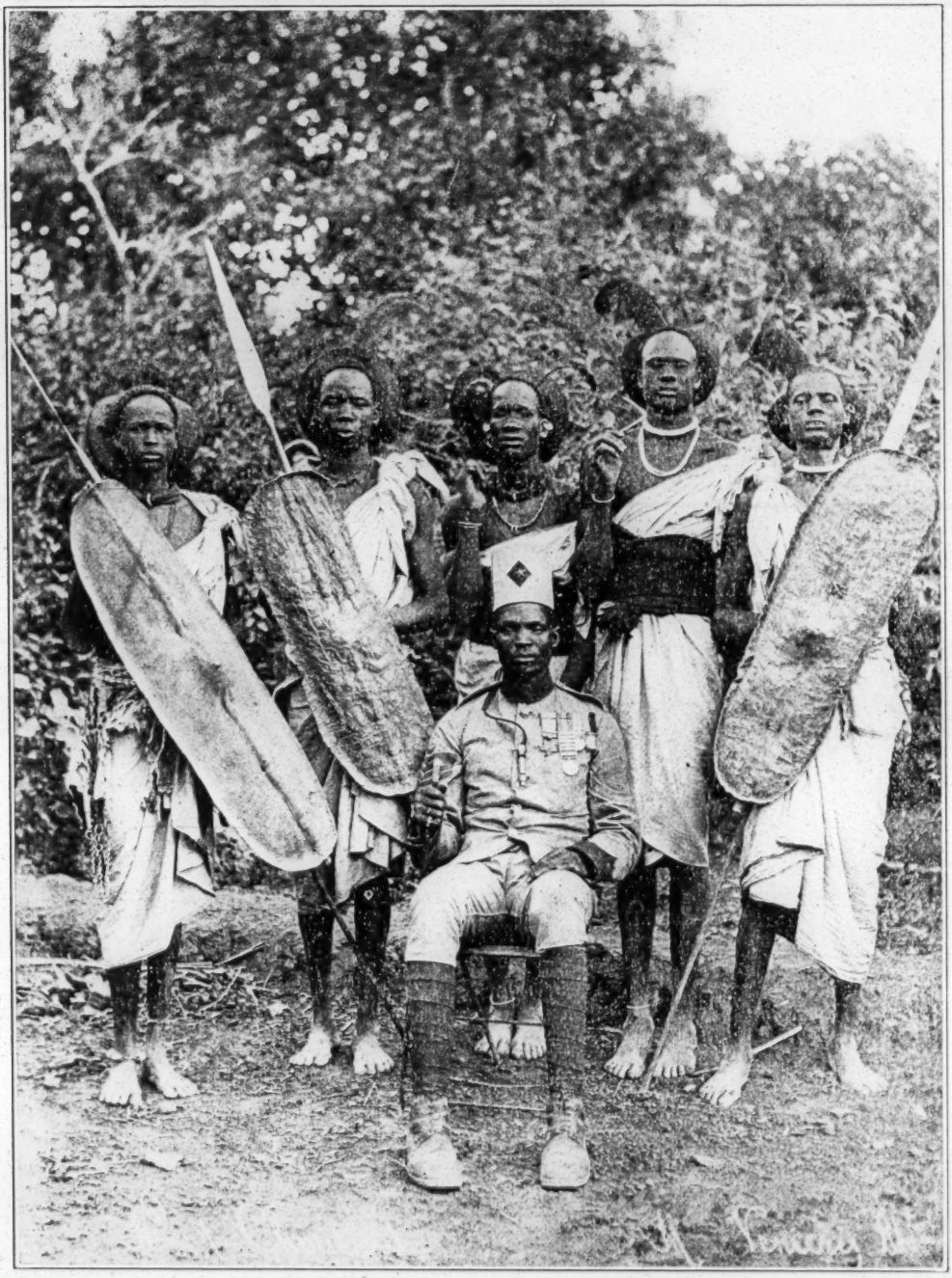


A Sudanese Policeman, Khartum

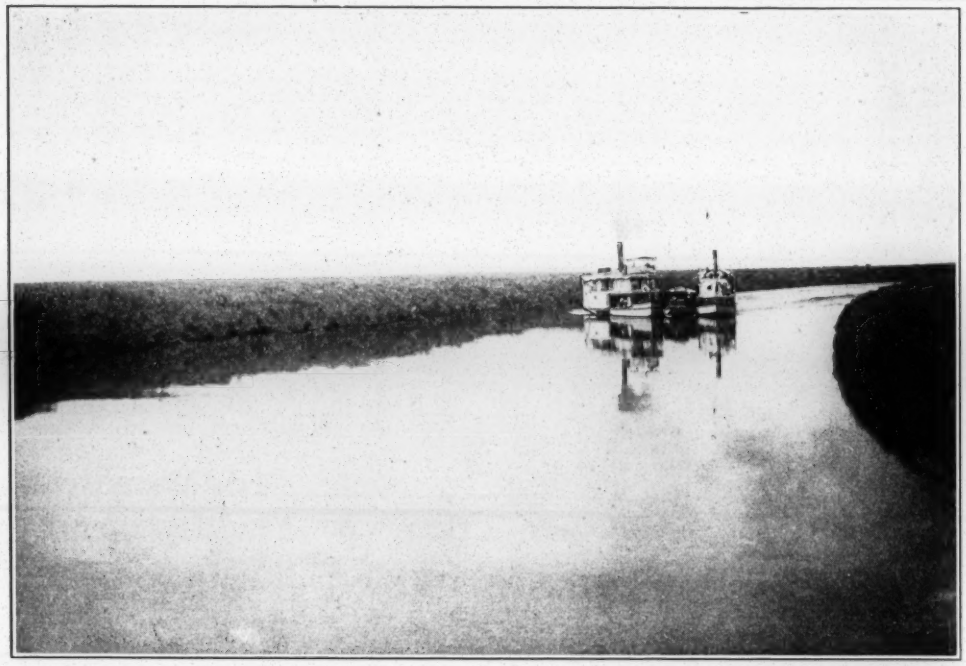
to do with this, for it is the last place on the west bank which can by any courtesy be called high land, on which a town could be built, before the great swamp of the "sudd" and the but lately unexplored country of the savages to the south is encountered. Here Baker, in 1871, found an Egyptian force and station, and on returning three years later, at the end of his campaign for the suppression of the



A Parade of the Shillook Regiment in Honor of Princess Beatrice, Khartum



Shillook Warriors. (See pages 255–256)



Advancing Through the Sudd. See page 263

Group of Convicts, Fashoda

slave trade, 700 human chattels, slipped through by the scarcely concealed cognizance of his royal master, Ismail Pasha. Here Emin Pasha took his leave of civilization when entering on that maze of experiences, a mystery even to this day, from which Stanley almost by force rescued him, and here only a few years ago Marchand from the westward debouched on the Nile, expecting to find men and arms from Abyssinia with which an alliance might be made to permanently check the British progress up the great river.

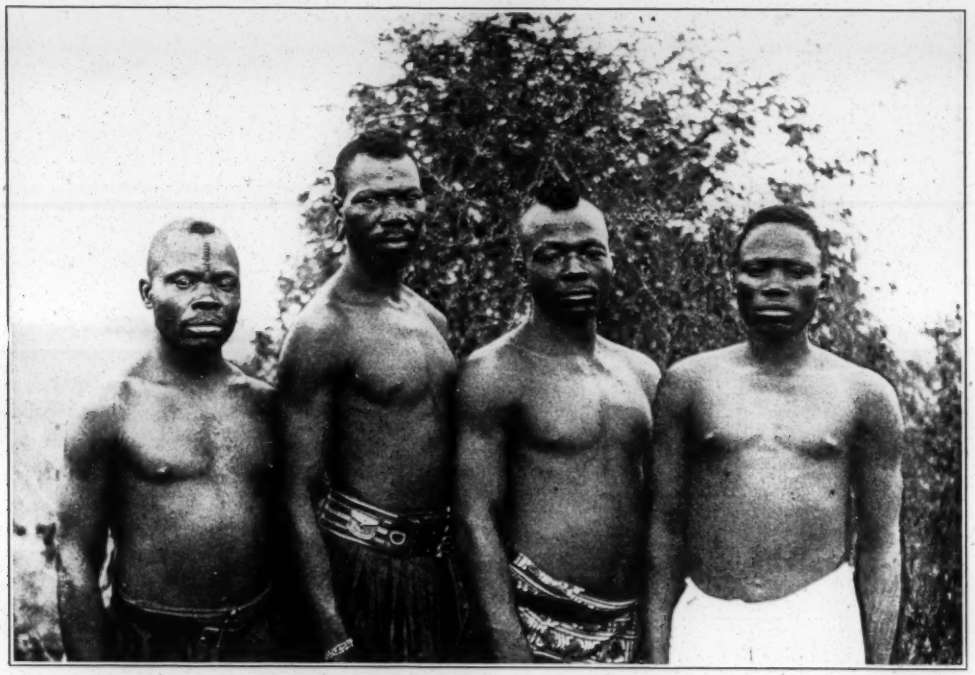
The name Fashoda has disappeared from official maps, documents, and publications, and Kodok, which suggests an American advertising opportunity, been substituted; but Fashoda it is in all the common speech of men everywhere and Fashoda it seems likely to continue.

It is interesting to note that the moral effect of the Kitchener-Marchand incident was most remarkable in all Egypt as determining finally the dominant power and indicating to what nation the future

of the continent was to be entrusted. The proportion of French pupils in the public schools of Alexandria dropped from 80 per cent to one-fourth that number, while that of English gained in exactly the same ratio, perfectly voluntary choice being allowed.

Fashoda, in spite of its history, is not well located; and one is rather inclined to commiserate the officers who are obliged to keep up the post as the chief of the province. The Nile at this point divides in three, and only at the highest stages can landing be effected. We were obliged to go ashore on the central island, cross it on muddy paths, and then were poled over a second shallow lagoon in a crowded boat, while the natives and permanent residents waded.

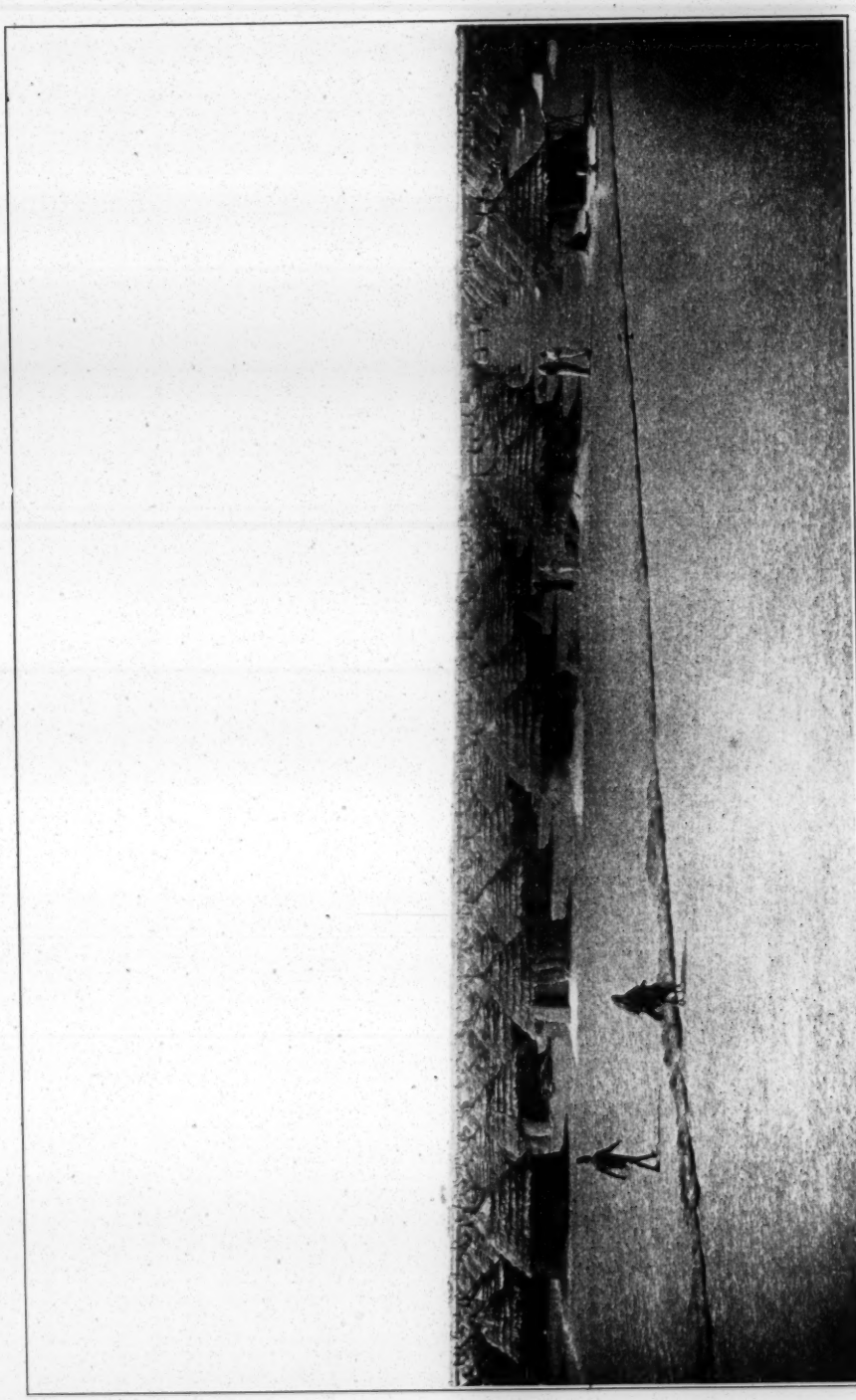
Tewfikieh, 70 miles farther up and on the other side of the river, is much more eligibly located, and from the extensive improvements which are going on there, many new buildings being erected by the government, it would seem quite likely that it may become the capital of the province. Tewfikieh is also very convenient to Sobat, which enters the Nile from Abyssinia only four or five miles above the town, and is charged with its protection, now that the old fort at the junction of the two rivers has been abandoned. The Sobat, it may be remarked in passing, is a river with a future. Traversing a highly fertile country for hundreds of miles, navigable without difficulty, it seems certain that it must come rapidly to the front, and the new trading and missionary stations soon to be established along its upper shores are the best guarantee of the fact.



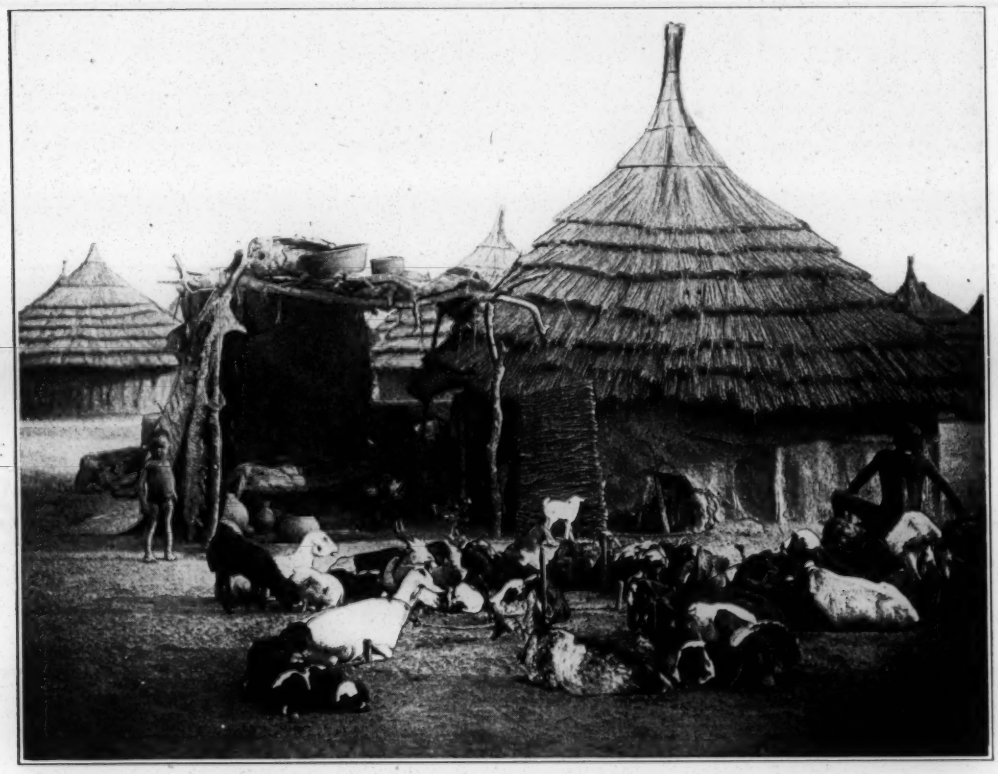
Types of Natives, Gondokoro

THE DESOLATE "SUDD" COUNTRY

Not far above the junction of the Nile and the Sobat, the scene changes and the great swamp, the country of the sudd, a



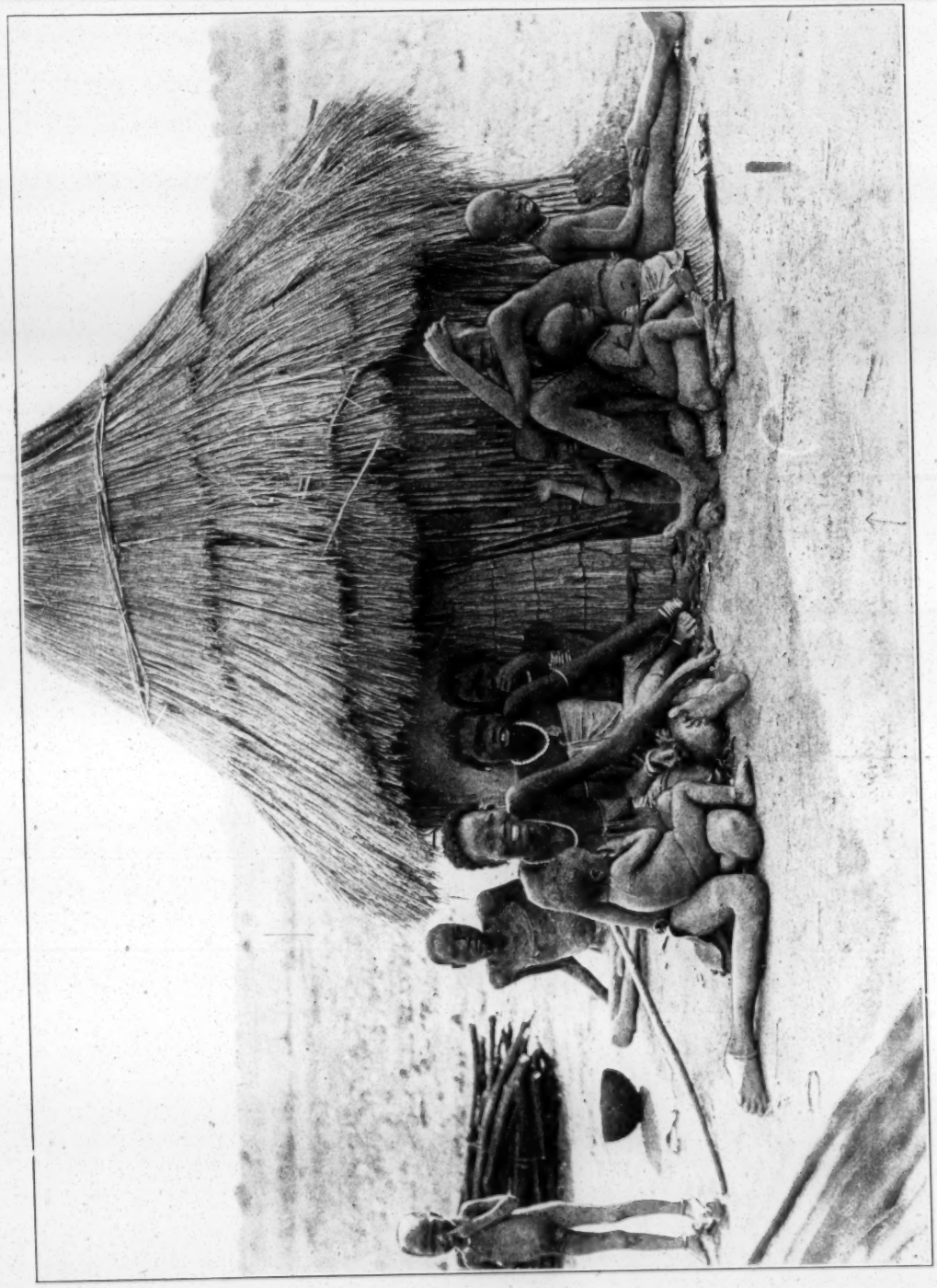
General View of Tewfikieh



One Thousand Miles up the Nile from Khartum

vast lake hidden under vegetation, is entered.

So much has been written and read about the swamp and the sudd of the Nile, which have for years together blocked navigation, that it may be superfluous to attempt another word; yet, like some other things of this life, these must be seen to be appreciated. Almost before one is aware of it the steamer enters a lane, hardly more than wide enough to admit it, lined on both sides with papyrus as high as the after deck and among which the water may be seen moving sluggishly. On the hurricane deck the view is more extensive, but without interruption or mitigation. In every direction as far as the eye can see stretches a boundless level expanse of green, so dense and solid that any casual breeze makes no motion, and unbroken by tree, dry land, or any other thing to vary the deadly monotony. Compared with this dead sea of green, the open ocean, far out of sight and land, is action, companionship, and inspiration. As the steamer passes along the zigzag channel, all signs of life—birds, insects (except the deadly mosquito), and every other moving thing—are left behind, and only the color of the papyrus prevents one from saying and writing "the abomination of desolation." The papyrus, which has practically exterminated all other vegetable growth in the swamp, lays claim to more literary distinction than it deserves, though it is by no means an ungraceful plant. Any one who recalls the common broom corn of the Connecticut and Mohawk valleys and the Illinois prairies may get a very good idea of the papyrus if he will simply imagine the stalk triangular



Nearing the Equator. A Village Scene at Bor

instead of round, and the "whorl" at the top spreading in all directions and seedless. As the boat pushes its way, the ripples of the water set the stalks swinging and the spray-like heads swaying in a picturesque manner; but other than this, motion is unknown. Of course, under the tropical sun the growth is rapid, and decay equally speedy. So the process of reproduction goes incessantly on, and all the activity and energy of man is required to keep the navigable channels open.

The course of the river through the swamps is tortuous in the extreme, and that the right channel can be kept, where there are two or three others which, to the untrained eye, look exactly like it, seems little short of marvelous. The distance traveled by the steamer from Khartum to Gondokoro, 1,150 miles, is about 300 miles more than that of the air line, the greater part of the excess being accounted for by the winding channels of the great swamps.

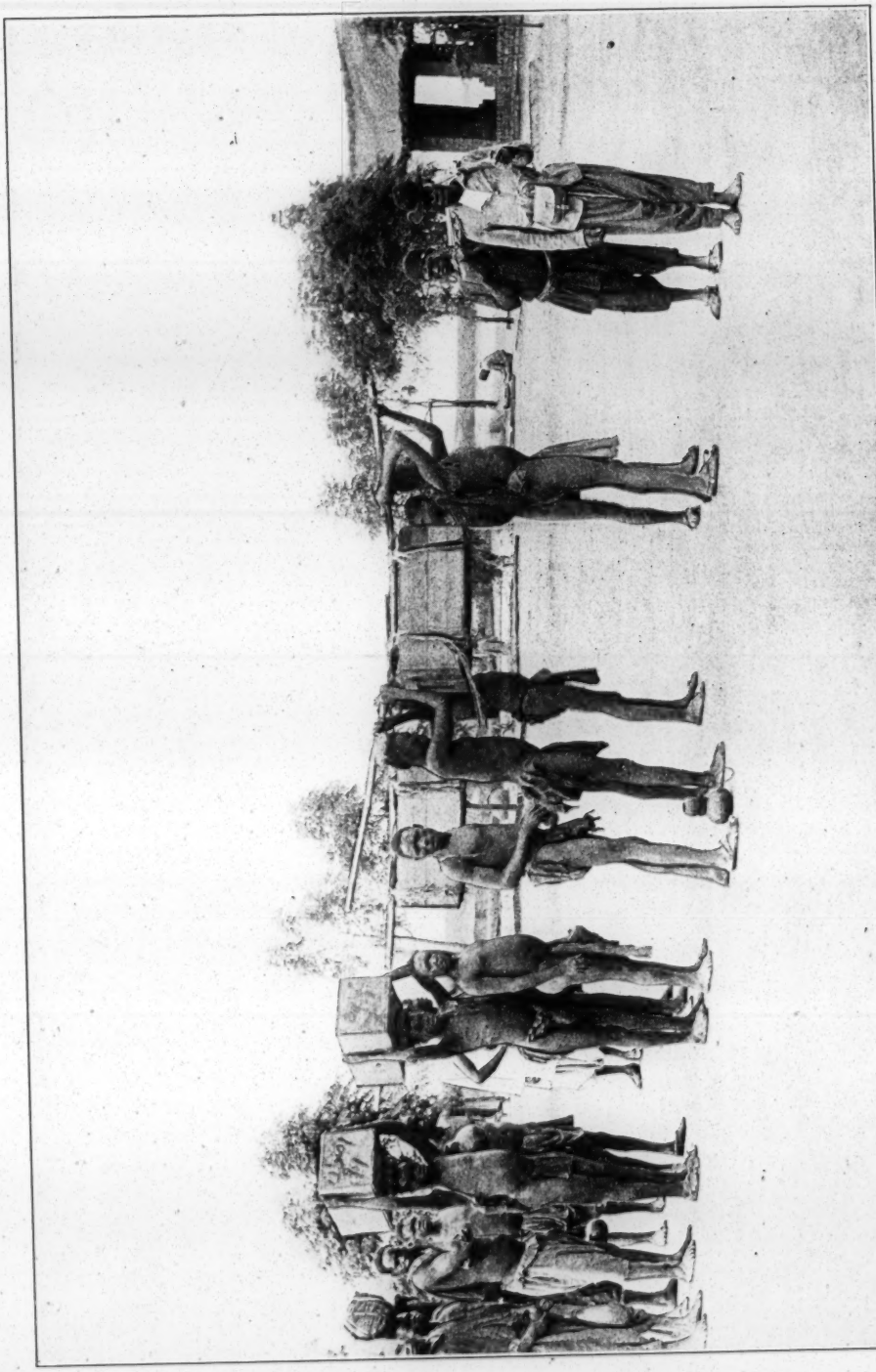
Cutting out the sudd, the blocks of papyrus, and other vegetable growths has been vigorously prosecuted by the Sudan government, and this season will see the last obstruction removed and the true channel opened from end to end.

At Bor, 1,071 miles from Khartum, established by Gordon thirty years ago as an Egyptian outpost, and now a wooding station, dry land appears, and one realizes how Noah must have felt after his memorable experience. The banks are low, not more than ten or a dozen feet high, but the everlasting papyrus disappears, tall reeds and waving grasses line the river, here not more than 50 yards wide, and in the near distance, over the rank vegetation, can be seen the tops of the forest trees. Conditions become more definitely tropical, and the shores often look like the true jungle. Wide-spreading trees droop festoons of vines, the queer inverted umbrella-shaped *euphorbia* becomes frequent, great cacti show themselves on the dryer spots, and altogether a world of wholly new flora is opened. The current is swifter, but the channel no straighter, the *Dal* and her two barges often lurching up like a drunken man unsteady in the gale against the bank, compelling her to back off and pull out as best she may. Less than a hundred miles remain of the journey after Bor, but it is all interesting and along a historic course.

LADO

The morning approach to Lado is particularly impressive when the sun lights up the great pyramidal Lado Mountain, which rises sheer from the plains 3,000 or 3,500 feet, a sight doubly welcome after the dead levels of the river country and the watery wastes of the swamps. Beyond Lado 20 miles through a pleasing and apparently fertile land the *Dal* pushes against the swift current until she moors against the steep banks and under the overhanging trees of Gondokoro, Baker Pasha's old Ismailia of more than 40 years ago. We are at the head of navigation on the Nile, unless that distinction may be allowed to Redjaf, the Belgian post 20 miles farther up, which runs a little military dispatch boat, with a flag several sizes too large for it, to Lado once or twice a week for officers and mail. Beyond Gondokoro east and south the mountains rise, outposts of the great Central African ranges, from which come the streams feeding Albert and Victoria lakes, and one really turns again toward the North Star and home with a sense of regret that the inviting journey southward may not be attempted; for there is a perfectly practicable post road for mails and porters 120 miles to Nimule; thence by boat to the head of Albert Edward Lake, and again on foot overland to the western terminal of the Uganda Railway, by which the Indian Ocean and all the ships that sail it may be reached at Mombasa.

By an arrangement which seems generous to the verge of safety and more liberal than precedent warrants, Great Britain during the remainder of the reign of King Leopold waives jurisdiction over the Lado enclave and yields to Belgium



The Mail Leaving Lado for Stations in the Congo Free State

use and occupancy nearly three hundred miles front on the west bank of the Nile and an approximately average equal distance from the river into the interior.

In the meantime the use of the Nile front is to Belgium almost indispensable; she is permanently strengthening the upper part of the Wadelai, though no one supposes she will be so foolish as to fight for it, and makes the Nile route the way for her officers going and returning and for the transaction of their personal business, notwithstanding that the mails still go by the overland Atlantic route. The difference is one month to Brussels by the Nile, against three or four by the Congo, and it's no wonder that every officer taking leave chooses the former.

Enough has already been ascertained to make it certain that the future of the Congo must be as an agricultural state. She may look with confident certainty to rubber, sugar, and cotton as staples, but of mineral wealth there is doubtful encouragement. Gold in paying quantities is known to exist in the southern province of Katanga. Iron ore is found in many places of satisfactory quality and well located for development, but both the coal and the limestone for smelting are so far lacking, and until iron becomes much scarcer in other countries or transportation will permit importation of fuel and flux, it is not likely that the Congo steel trust will amount to much. As an agricultural country, however, its consumption of iron will not be large and the situation is not one of much economic importance. The mineral survey has a good deal of unexplored country yet to examine, for it should not be forgotten that the Congo Free State covers nearly ten million square miles, being twenty degrees of latitude from north to south, or would be if its salient or re-entering angles were straightened out, and years must necessarily elapse before its full condition and capabilities are known. Many believe that in the gold of the Katanga alone Belgium has in the Congo a prize which may some day rival the great wealth of the South African Rand.

Of course, brief visits, largely formal and superficial, do not qualify for any authoritative opinions on the Congo outrages of which so much has been said.

Impressions, however, may be taken for what they are worth, and certainly not only what was seen, but what was heard at Lado and Kiro was distinctly and altogether favorable. Everybody, particularly the black soldiers and their women, looked contented, well fed and clothed and happy, and a better-looking lot of men and women could not be mustered at any British or American military outpost. If they were oppressed or badly treated they certainly had a most effective way of concealing all signs of it, and the wholesale re-enlistment confirms the favorable conclusion. British sportsmen who have traveled widely in the Congo tell the same story of good order and content at every post.

There is, however, an evident deep-seated, probably ineradicable, opposition among many Englishmen to the permanent establishment of the Belgians in the Congo, and they look eagerly for any change which will drive them out of the Lado enclave and restore both sides of the Nile, from the Mediterranean to the Equator, to the British flag. Especially is the feeling strong among the missionaries, who complain of undue favoritism to the Catholics in the Congo, and who, when they let themselves go, predict that this change will come of necessity and at no distant day. "The Belgians," they say, "are no colonists, as we are, intent on the national development and permanent growth of the country. Their whole Congo enterprise, stripped of high-sounding names, is simply a great trading proposition, rubber the loot and the natives meat, and when they have got all out of the country they can they will simply scuttle, and we shall have to take it over or it will revert to savagery." But this is probably an extreme view or, still more likely, the wish is father to the thought.

THE "BREAKING UP" OF THE YUKON

By Captain George S. Gibbs

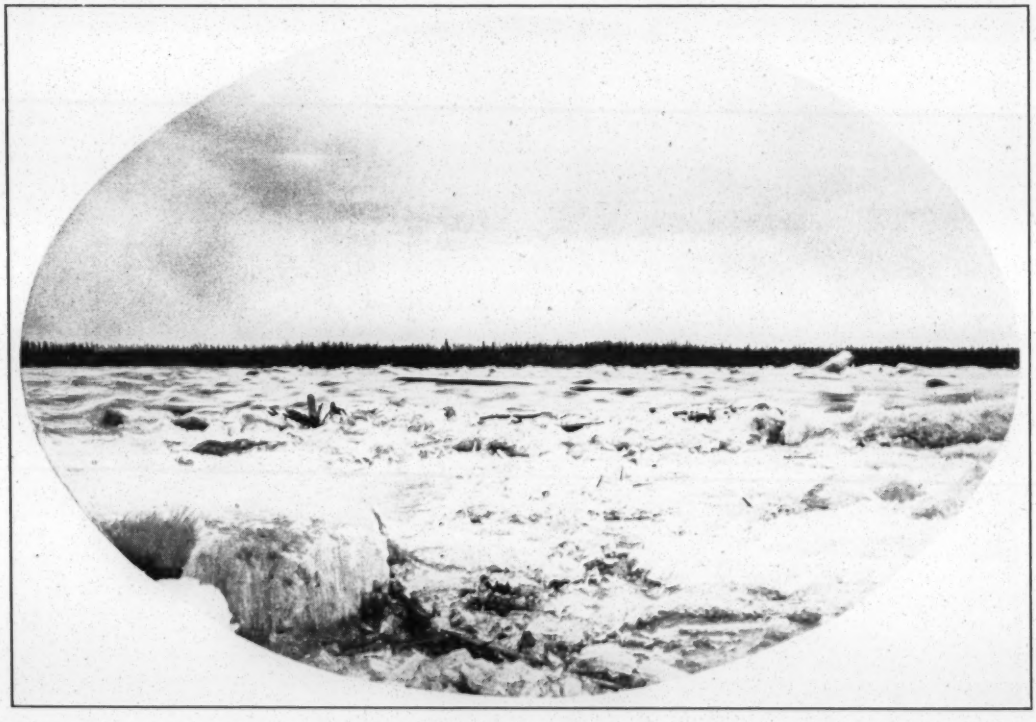
Signal Corps, U. S. Army

LONG after the cold days of arctic winter have given place to continuous day, with warm summer breezes and still warmer summer sun, Alaska still requires an all-important finishing touch to usher in its "open" season—that is, the clearing out of its mighty highways, the rivers, of the ice that for seven months has borne its sledge trails.

How anxiously this great event is looked forward to by the long-imprisoned inhabitants and the feelings of freedom and relief that it brings can only be understood by those who have participated in the celebration of this occurrence at the scattered settlements along the thousands of miles of Alaska's great rivers.

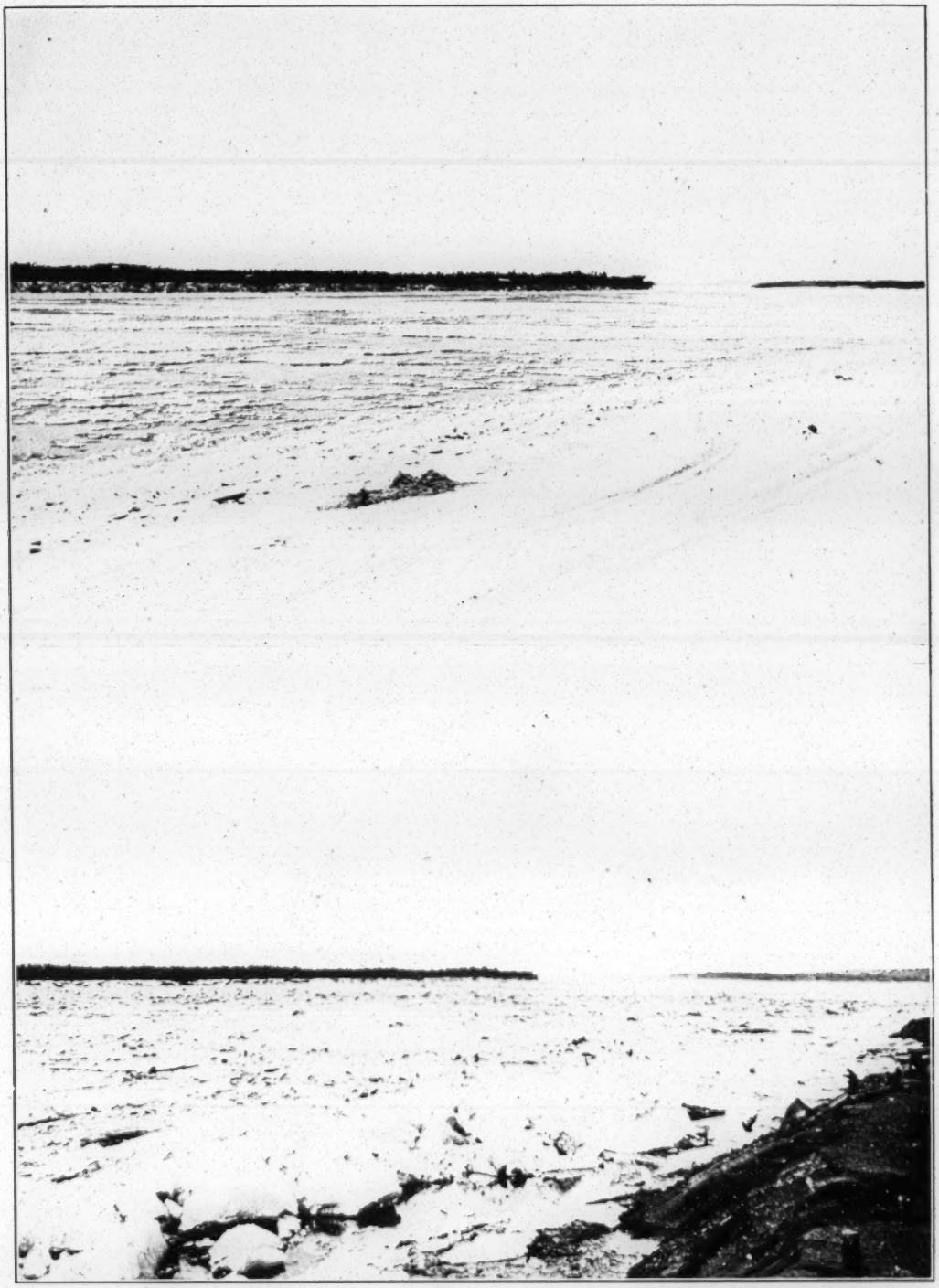
The shutting-in process in the fall is gradual. The level of the water drops daily; the ground is covered with successive snows, and patches of ice coming out of the small streams amalgamate upon the broad surface of the river into larger floes, which become larger and thicker with the lowering temperature and cementing snows, until some day about the first of November a great mass is stopped against the head of an island and in a few hours you can walk across on a solid and safe footing.

The break-up in the spring is no such



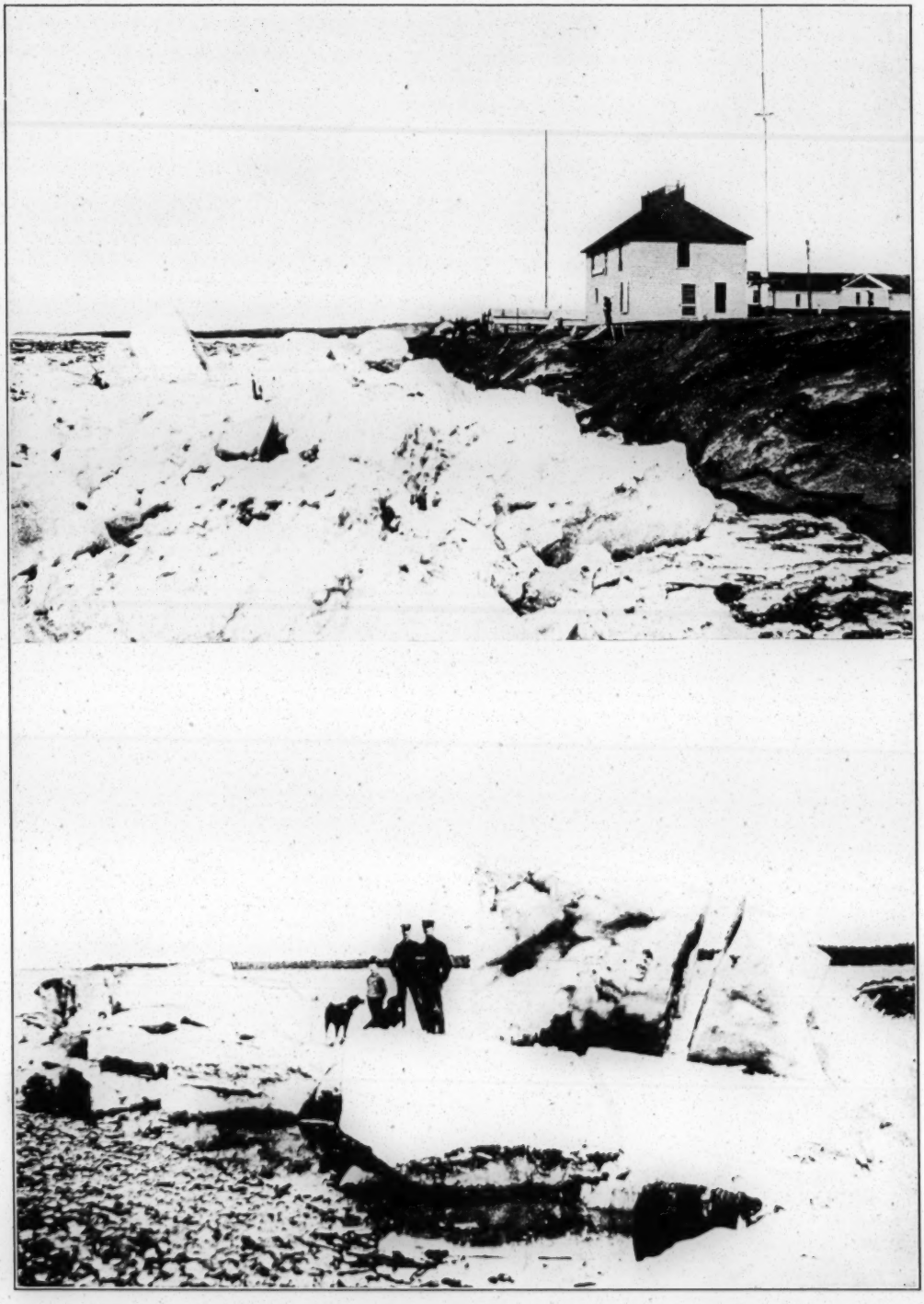
The Yukon River "Breaking up"

An irresistible torrent of more than three million tons of water per minute. Photo by Sergeant Moore



1. This picture, taken at Fort Gibbon late in October, shows the extreme low stage of water, and the surface of the Yukon becoming choked with gathering floes of ice. Photo by the author

2. Taken on the 23d of May from the same point as No. 1, during the outward rush of the ice. Photo by the author



1. The bank of the Yukon at Fort Gibbon being piled high with ice. Compare the size of the chunks with the man on the bank. The large chunk on the left was rearing like a gigantic monster as the picture was taken. Photo by the author
2. Immense chunks forced by their fellows far up on the bank. Photo by Mr R. Pfund

Destruction wrought by the Ice Floe. Photo by Major Greene

tame affair. By the first of May the days have become long and the sun hot, and soon the snow, which has been growing scarcer and dirtier, has mostly disappeared. How strange, then, that the general appearance of the great, silent river has changed but little! Its torpid, frozen length stretches along between banks already green and fresh with budding leaves and spring flowers.

As May advances, every small stream contributes its share of a mighty volume of water; and then, following along either bank, a narrow stream covers the shore ice. Meanwhile the main body of ice has been raised several feet by the swollen flood beneath it; and that, with the gnawing action of the water along the bank, at last loosens the hold of the ice upon the shore.

Apparently ready to move, the ice may not start for days; but finally the rising tide will carry away a section from the main body, and then the demolition begins. A dark pile of refuse out on the ice, or other reference mark, is seen to move, and a shout from a watcher brings every human being to the river bank to witness the rare spectacle.

At first the great body of ice, five feet thick and a half mile wide, moves down intact; but soon a bend is reached, or the channel divides, and, with a mighty roar that can be heard for miles, this great mass is shattered. Blocks of ice weighing many tons each rear and dive and grind and roar like huge monsters in a deathly panic. They crash into each other, gouge out and carry away yards of the river bank, and crush any obstructions in their path. At the meeting of every bend or shallow immense chunks are forced by their fellows far up on the bank and in places form piles as high as a house. When once out on the bank and free from the seething flood, these great ice chunks, lying on the warm earth in the hot sunshine, seem as strangely out of their element as fish thrown out upon the burning sand to die. There they lie until they become whitened bundles of slender lance-like crystals whose invisible bonds

at last break and let them fall with a musical crash into countless disappearing fragments.

For many days the ice runs. The upstream branches are cleared first, and steamboats and smaller craft follow closely the retreating ice. Some daring travelers have tied their boats to large chunks of ice in order to take advantage of the greater speed of the under current.

It is usually past the middle of June before the mouth of the Yukon is free from ice, and the termination of the annual break-up is announced by the "chug," "chug," of the welcome upcoming steamboat, laboring against the current.

A most beneficent phenomenon accompanies the spring "break-up," with its outrushing flood of more than three million tons of water per minute. During the extreme high stage of water, which lasts for perhaps two or three weeks, great sections of the heavily wooded bank are undermined and swept away. The majestic spruce trees and tamaracks and birches which covered them topple over and are swept down by the current, along with immense quantities of driftwood from the forest beds. The entire accumulation, amounting to thousands of cords of wood, is discharged into Bering Sea, whose restless waves and shifting winds scatter this fuel and pile it up on barren shores hundreds of miles distant.

The prospect presented by these arctic shores is as bleak and desolate as can be imagined. The landscape is destitute of timber as far as the eye can see, and the inhabitants of that inhospitable region have had occasion to be very grateful for these peculiarly valuable contributions from the distant valley of the Yukon.

MOUNT VESUVIUS

VESUVIUS has been violent many times since the notable eruption of 70 A. D., when Pompeii and Herculaneum were buried, but the eruption of 1906 will rank among the most destructive. Many villages were overwhelmed by streams of lava and falling ashes, so that years will elapse before the country recovers from the devastation. The mountain is reported to have lost about 800 feet in height, but it does not take the volcano long to rebuild. Vesuvius has now been watched for about two thousand years, and we are better acquainted with it than with any other volcano, but its actions are so mysterious that practically nothing is known of the causes which make it break out at intervals with such violence.

No five years in history have been so noted for volcanic disturbances as the years 1902-1906. The explosion of Mont Pelée, which destroyed 30,000 people; the eruption of Santa Maria in Guatemala a few months later, which likewise swept away thousands of people and wrecked many miles of fertile plantations; the activity of Colima in Mexico, and of Mauna Loa in Hawaii, and now this latest eruption of Vesuvius, form an unprecedented series of disasters. They serve to emphasize our ignorance of volcanic action; and yet this ignorance is not to be wondered at, for no systematic study of volcanic action has ever been made. Commissions have been sent to study individual volcanoes—Vesuvius, Mauna Loa, Krakatoa, Mont Pelée, etc.—but no prolonged comparative investigation has been made of all of them. Probably no field of scientific inquiry would yield such valuable results as a careful study of the volcanoes of the world.

Near the shore west of Naples is Monte Nuovo, or new mountain, a hill 440 feet high, cast up by volcanic action during a few days in September, 1538. All about it are volcanic hills of earlier origin, and two islands bordering the bay are also volcanic.

About 150 miles south of Vesuvius is Stromboli, which is always active and is

Photo from Mrs Gardiner G. Hubbard

A Street in Naples

Photo from Mrs Gardiner G. Hubbard

Naples and Vesuvius. The lower cone is called Mount Somma

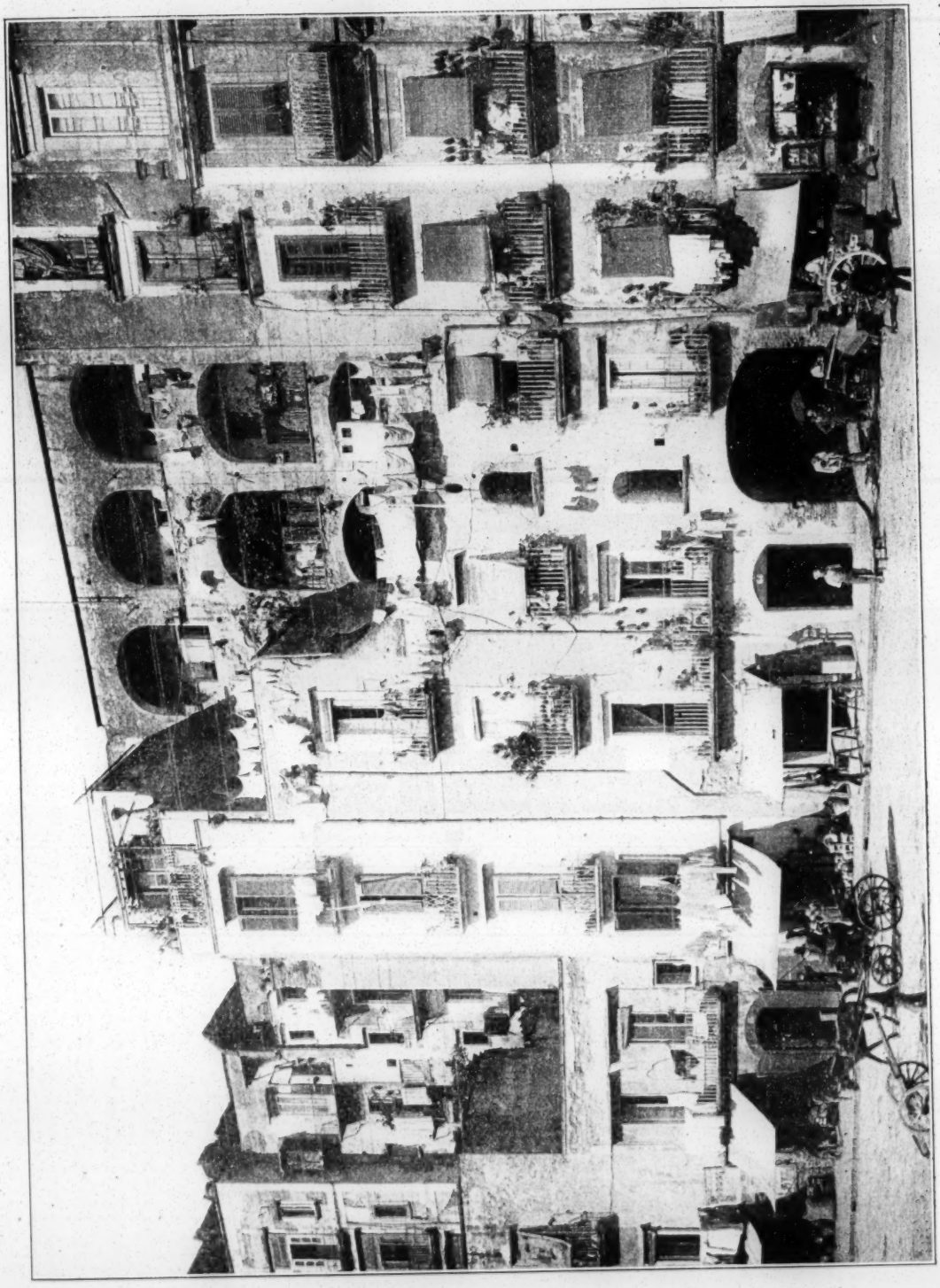


Photo from Mrs Gardiner G. Hubbard

Houses in Naples

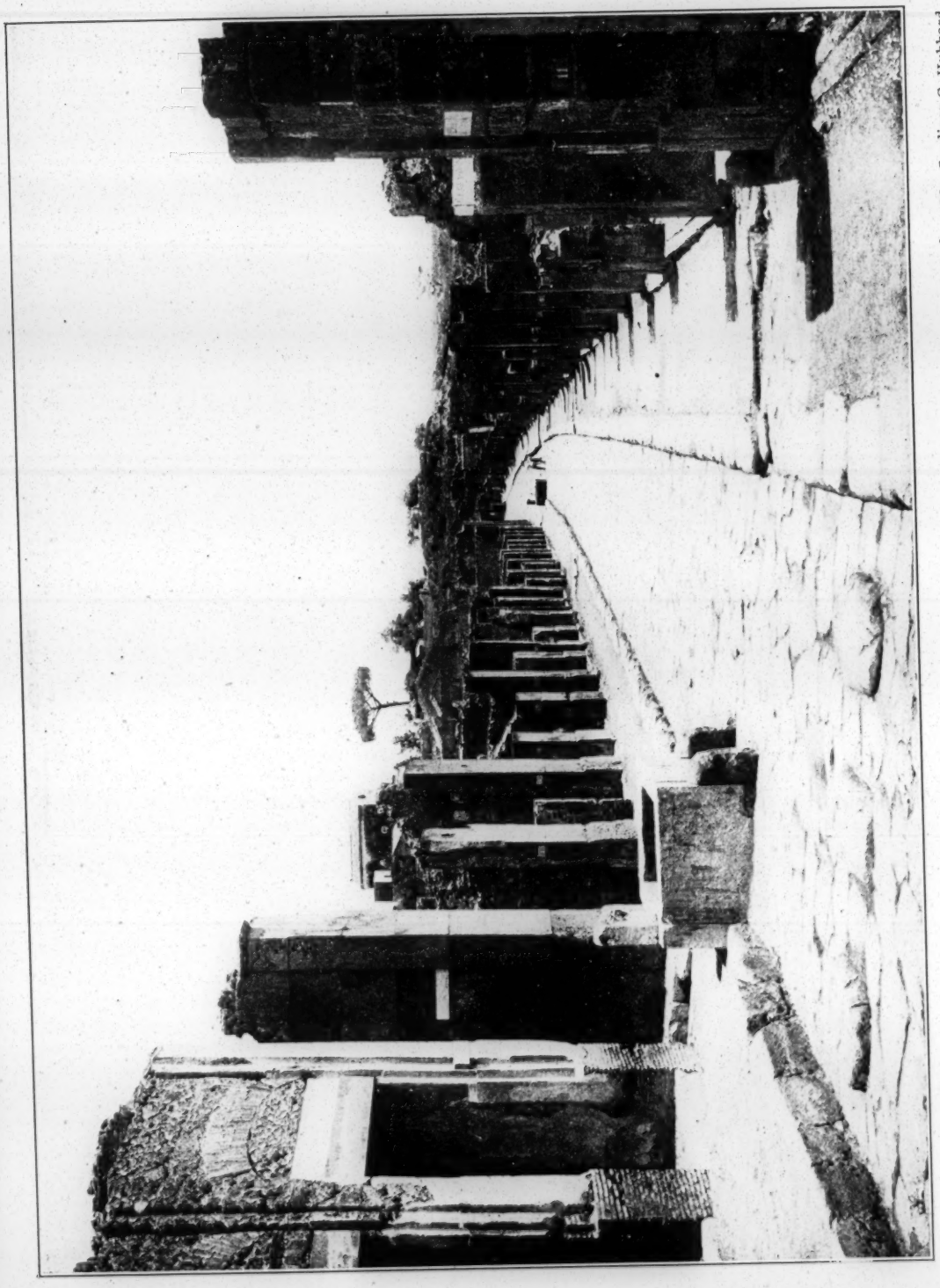


Photo from Mrs Gardiner G. Hubbard

A Street in Pompeii

Photo from Mrs Gardiner G. Hubbard

A view of Amalfi from the old Convent of the Cappuccini, which was founded in 1212, and is now a hotel. Nearly every visitor to Naples visits this town, which is noted for its historic interest and the wonderful scenery enjoyed on the approach to it by the carriage road

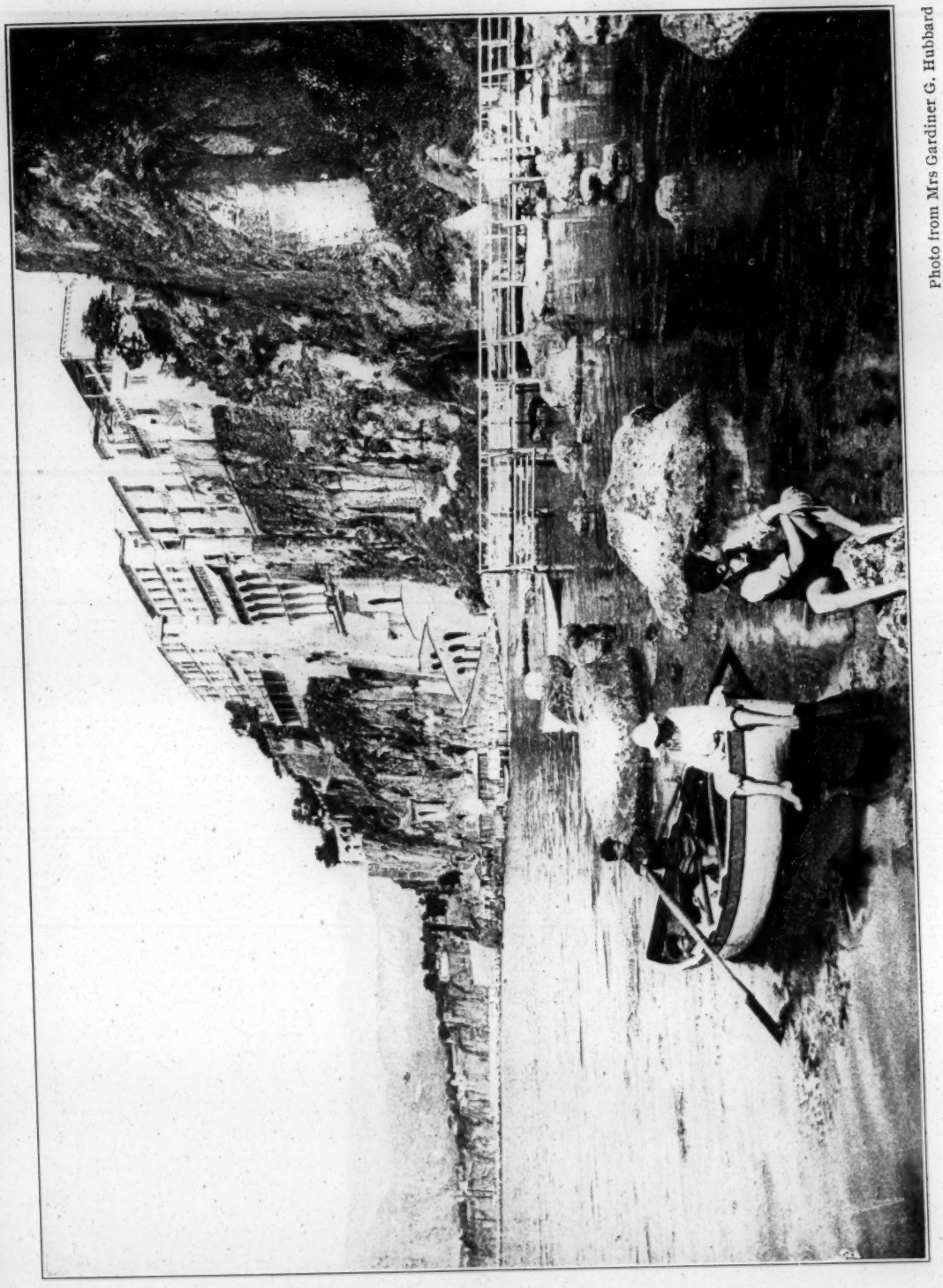
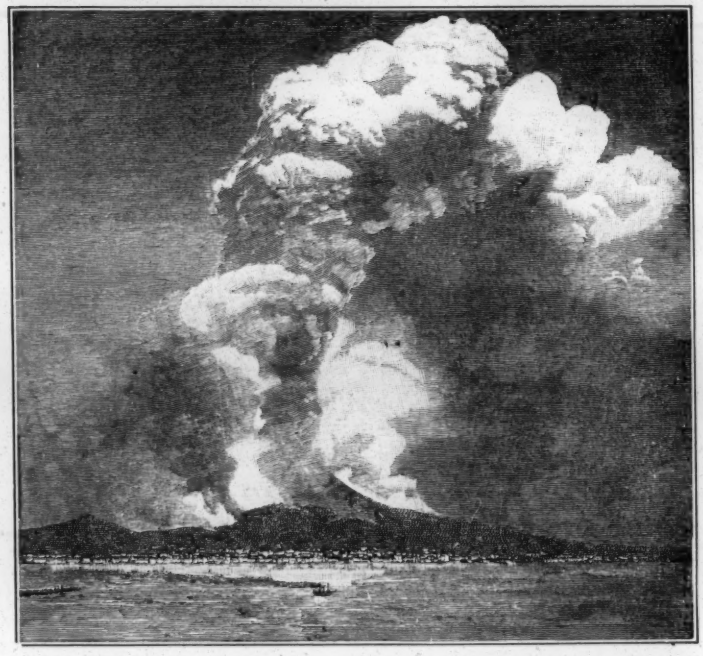


Photo from Mrs Gardiner G. Hubbard

Sorrento, which Overlooks the Bay of Naples

familiarly called the "Lighthouse of the Mediterranean."

Still southward, close by the eastern shore of Sicily, rises another volcano, also famed in classic myth, and in comparison to which Vesuvius is but a mound. Etna is more than 10,000 feet in height and has a circumference of 40 miles. Like Vesuvius, this vast cone is built chiefly of lavas and ashes coming to rest about a central pipe or throat leading up from the depths, but there have also been many small eruptions on the flanks. From time to time cracks open on the sides of the great cone, allowing the escape of lava and cinders and causing small cones to be built. Like other great mountains, it has a rugged surface, and rises through several zones of climate, being almost tropical at base, temperate and forested on its middle slopes, and arctic and snowy on its summit.



From "Physical Geography," by William M. Davis and W. H. Snyder
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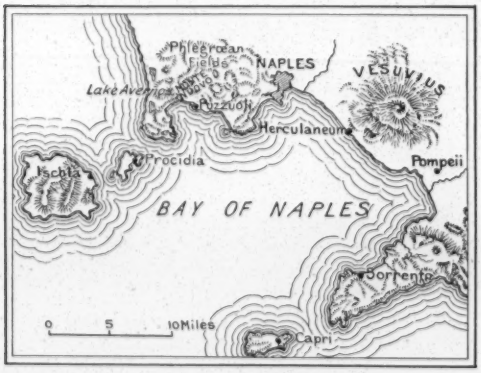
Vesuvius in Eruption

In 1831 the sea south of Sicily gave a fine illustration of the volcanic habit of that great region. At a point where the water was 600 feet deep volcanic materials were cast up until they stood 200 feet above the water. This new island, however, was soon cut away by the sea waves, leaving a shoal where the transient land had been.



Some good books describing volcanic action are:

"Introduction to Physical Geography," by G. K. Gilbert and A. P. Brigham (Appletons).

"Physical Geography," by Wm. M. Davis (Ginn & Co.).

"Volcanoes of North America," by Israel C. Russell (Putnams).

"Volcanoes; their Structure and Significance," by T. G. Bonney (Putnams).

"Text Book of Geology," by Sir Archibald Geikie (Appletons).

"Geology," by T. C. Chamberlin and R. D. Salisbury (Henry Holt), 3 vols.

THE PROBABLE CAUSE OF THE SAN FRANCISCO EARTHQUAKE*

By Frederick Leslie Ransome

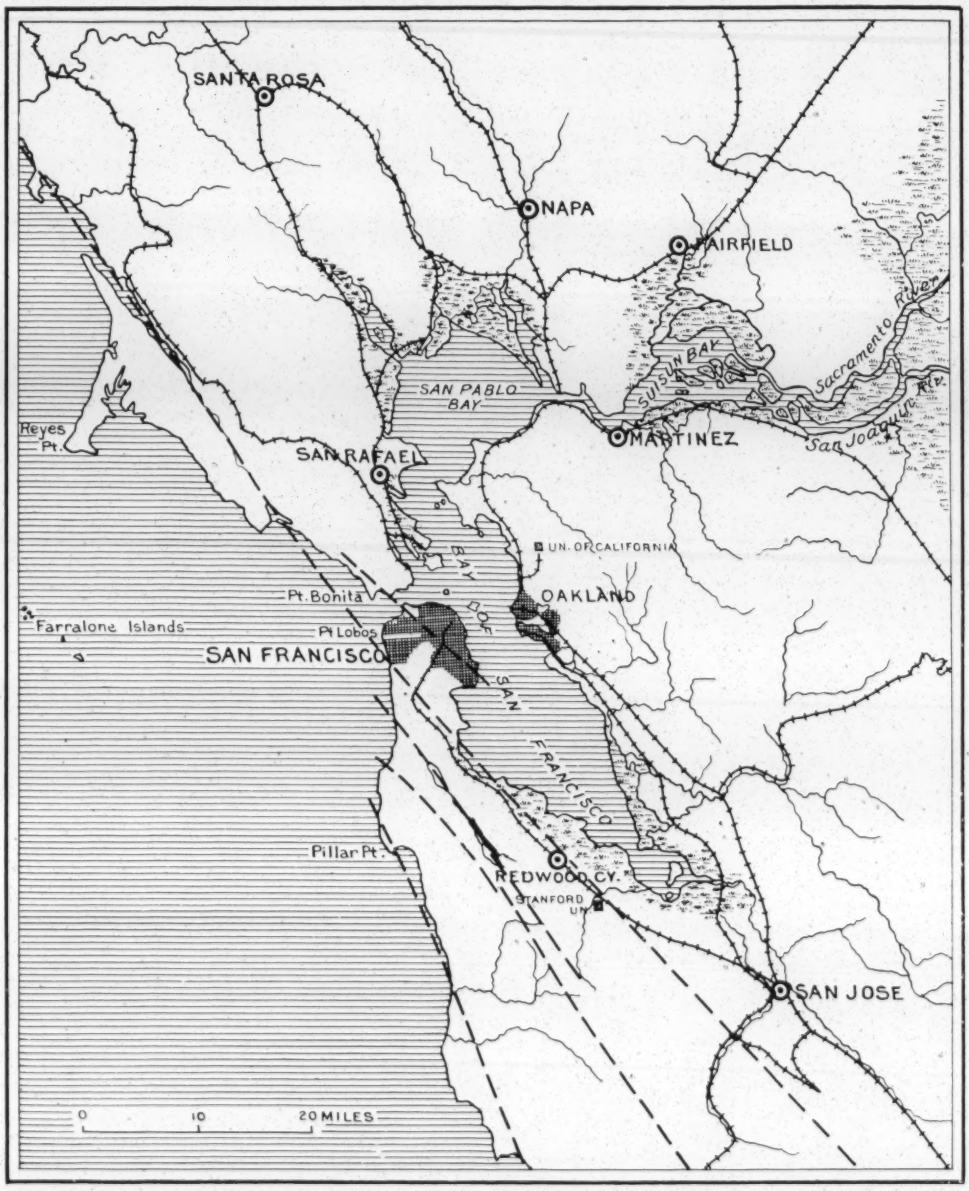
Geologist, U. S. Geological Survey

AS these words are written, three days only have passed since San Francisco was shaken by the most destructive earthquake in her history, and the subsequent unparalleled ruin wrought by fire is not yet ended. In such a stunning disaster, when communication with the outside world is interrupted, when to the heart-shaking terrors of heaving ground and toppling buildings is added a form of devastation even more appalling, and when the human aspect of the tragedy so overwhelms all other considerations, it is impossible to obtain at once and at a distance from the scene the data necessary for a satisfactory explanation of the initial catastrophe. The few facts that can be gathered for this purpose from the moving story of destruction, heroism, and fortitude are meager indeed, and the sciolist alone would pretend to find in them adequate material for deducing the real cause of the earthquake. Nevertheless a brief account of the geological history and structure of the region adjacent to San Francisco Bay may be of interest to those who are not professional geologists or who have never had an opportunity to study for themselves this part of the coast of California. Such an account will show that the present disaster was not altogether unexpected, and that the rocky structure of the peninsula upon which the city stood—in fact, of the whole Coast Ranges—suggests the probability of serious seismic disturbances in the future. It will serve, moreover, as regards this particular catastrophe, to eliminate improbable guesses as to cause and to supply a basis of fact that will aid in the intelligent interpretation of information which will gradually become more detailed and accurate as excitement subsides and communications are restored. That the following hastily prepared sketch, involving consideration of so complex a subject as the geology of the Coast Ranges, must in many respects be unsatisfactory and imperfect is of course freely admitted and, under the circumstances, seems hardly to require apology.

CAUSES OF EARTHQUAKES

Most authorities on earthquakes distinguish two main classes—(1) volcanic quakes and (2) tectonic, or dislocation, quakes. The former originate in districts of active vulcanism and at comparatively shallow depth. According to Major C. E. Dutton, the greater number of such shocks are initiated at depths less than 2 miles. They are characterized by a fairly definite centrum, a relatively short radius of influence, and the absence of subordinate after-quakes. They are phenomena that could probably be closely imitated by the explosion of a large quantity of dynamite at the bottom of a deep mine. Tectonic quakes, on the other hand, may originate at greater depth; they usually have indefinite or elongated centra; they are characterized by a greater radius of activity, and the main shock is usually followed by after-quakes. Most of the great destructive earthquakes recorded in history belong to this class. Such, for example, was the Mino-Owari earthquake in Japan, which in 1891 killed over 7,000 people, wounded over 17,000 more, and destroyed more than 200,000 houses. This quake was plainly caused by movement along a fissure which appeared at the surface as a fault about 70 miles long,

*For a comprehensive description of earthquakes the reader is referred to that interesting book, "Earthquakes," by Major Clarence E Dutton, published by G. P. Putnam's Sons.



Outline Map of San Francisco Bay and Vicinity. Principal known faults are indicated by heavy dash lines

with a maximum throw of 20 feet. Prof. John Milne, after an exhaustive study of the seismological records of Japan, concluded that shocks are most frequent in districts that exhibit evidence of elevation or subsidence still in progress.

Four kinds of waves are generated in most earthquake shocks: (1) normal waves, (2) transverse waves, (3) surface waves, and (4) epifocal waves. The first three depend upon the elasticity of the rocks traversed, are not visible, and,

although propagated with different velocities, are not always distinguishable. The last are the visual waves, resembling, as Major Dutton says, flat waves on water. They are characteristic of the epicentral tract of many great earthquakes and are highly destructive. They bear no clear relation to elasticity and result from the passage of the deeper waves from an elastic medium (solid rock) into a feebly elastic medium, such as soil or unconsolidated sediments. They thus account for the ruin often wrought in valleys and in low ground when structures on near-by hills escape.

EARTHQUAKES VERY FREQUENT IN CALIFORNIA

The frequency of earthquakes in California is well known, and tremors sufficient to rattle the windows of dwellings in San Francisco have in the past been so common as to excite little alarm and arouse but passing interest. The number of quakes recorded in San Francisco from 1850 to 1886 is 254, and 514 additional shocks were noted in the same period in other parts of California. They are undoubtedly more prevalent in the region surrounding the Bay of San Francisco than in the northern or southern extremities of the state. While most of the recorded quakes have effected no damage, others, such as the great shock in 1868, which injured San Francisco, the Owens Valley earthquake in 1872, the Vacaville earthquake in 1892, and the Mare Island earthquake in 1898 were notably destructive. In general, it may be said that the earthquakes in California exhibit the features characteristic of tectonic quakes, and the Owens Valley shock is generally ascribed to movement along the great fault limiting the Sierra Nevada on the east.

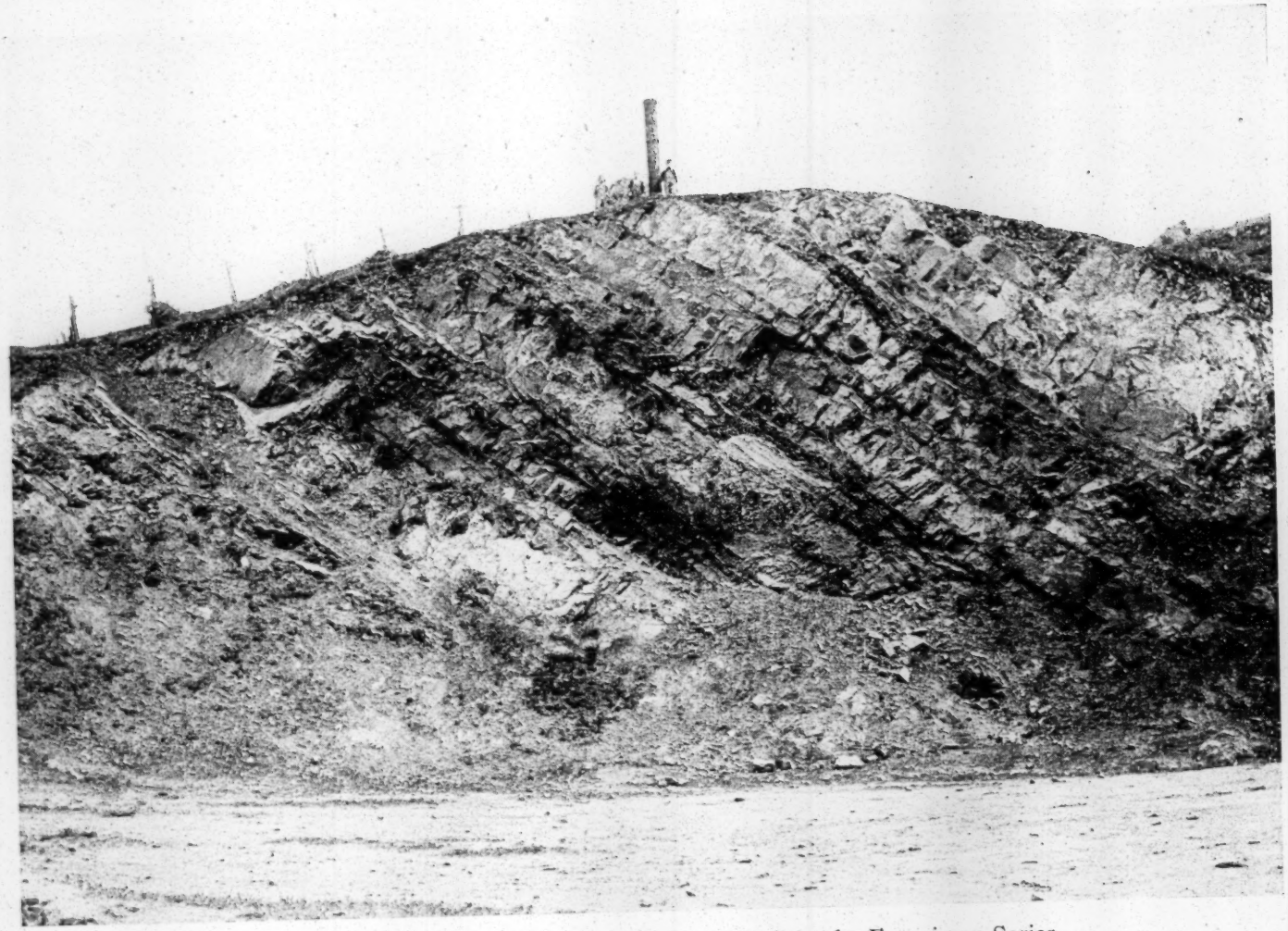
A section across central California, we will say from Monterey Bay to Mono Lake—shows three well-marked topographic divisions. On the northeast is the gentle western slope of the Sierra Nevada, about 70 miles broad, which rises gradually from the eastern edge of the main interior valley to the crest of the great scarp overlooking the deserts of Nevada. The range is essentially a huge fault block composed of Jurassic and older rocks and partly covered by Tertiary lavas.

The Great Valley is in the main an alluvial plain 50 to 60 miles wide, its northern part drained by the Sacramento River and its southern part by the San Juaquin. Both streams flow into the head of Suisun Bay and their waters find their way across a depression in the third topographic division, the Coast Range, through San Francisco Bay and the Golden Gate into the Pacific.

The Coast Range separates the Great Valley of California from the Pacific Ocean. It comprises numerous nearly parallel ridges separated by narrow alluvial valleys and constitutes a generally mountainous belt some 60 miles in width. Both in lithology and structure it presents a marked contrast to the Sierra Nevada, although the relations of the two ranges in the northern and southern parts of the state are not as yet fully understood.

THE COAST RANGE IS YOUNG AND IS STILL GROWING

The oldest rocks known in the Coast Range are limestones and quartzites, with some crystalline schists, and are exposed at various localities from Point Reyes, north of San Francisco, to San Luis Obispo. These rocks, which are probably Paleozoic, are cut by granite supposed to be of the same general age as the main granitic intrusions of the Sierra Nevada, which are known to be post-Jurassic. All of these rocks, after being above sea-level long enough to be extensively eroded, were submerged and were covered by a series of sediments several thousand feet thick, known, from its characteristic development at San Francisco and on the north side of the Golden Gate, as the Franciscan, or Golden Gate, series. Although the Franciscan consists mainly of sandstone such as forms the well known Telegraph Hill in San Francisco and the



A Typical Quarry Exposure of Sandstone Beds in the Franciscan Series

This is the most common rock near San Francisco. It forms most of the conspicuous hills upon which the city is built, the principal islands in the bay, and most of the north shore of the Golden Gate

Radiolarian Chert at Hunters Point

These thin-bedded jaspery rocks are very characteristic of the Franciscan series. They are made up largely of the siliceous skeletons of the minute marine organisms known as radiolaria. On account of its hardness the rock is much used for macadam. The smooth red driveways in Golden Gate Park, familiar to visitors to San Francisco, are paved with this chert.

larger islands in the bay, it contains also some of the most interesting and characteristic rocks of the western coast, such as the serpentines, the blue glaucophane schists, with their wonderful mineralogical variety, and peculiar jaspery rocks made up in part of the siliceous skeletons of radiolaria. The age of the Franciscan series, which forms a large part of the Coast Range, is still open to question. It is thought by some geologists to be Jurassic, by others to be early Cretaceous.

The deposition of the Franciscan sediments was ended by an upward movement of the sea bottom. They were folded and faulted, lifted above sea-level and eroded by streams and waves. Again, however, the land went down, the Franciscan rocks sank beneath the sea and were covered by thousands of feet of fossiliferous Cretaceous, Eocene, and Miocene deposits. The sediments of the last period alone attained a thickness of over 8,000 feet. At the close of the Miocene and after minor oscillations of level the rocks were again raised above sea-level and were crumpled and faulted by the energy of the uplift until they formed a well-defined range separating the ocean from the interior valley.

In Pliocene time the land again subsided, although the Coast Range was probably not wholly submerged, and marine deposits of this period were laid down in sounds or inlets.

Here belongs the San Pablo formation, a thick accumulation of sandstones with intercalated volcanic tuffs. Apparently during the later stages of San Pablo deposition new movements of the land took place whereby fresh-water basins were formed, in which accumulated over 3,000 feet of sediments and lava flows—the Berkleyan and Campan series of Professor Lawson. Nor is this all. Still later in the Pliocene was deposited the Merced series, which is exposed along the ocean beach west of San Francisco. This remarkable deposit, described and named by Professor Lawson, is a mile in thickness and has at its base the well-preserved remnants of a coniferous forest. Thus a portion of the Tertiary land upon which pines, indistinguishable from the species were growing now common at Monterey, sank beneath waves to a depth of at least 5,000 feet, and so rapidly that the trees were buried under sediments before they could decay. Finally the Merced series, carrying in its upper beds fossils of *Quaternary* age—the mere yesterday of geological time—have been elevated above sea, tilted up at angles as high as 75 degrees, and dislocated by a fault of at least 7,000 feet throw.

THE COAST RANGE COMPARED TO THE ATLANTIC SEABOARD

In order that the full significance of this epitome of the marvelous history of the Coast Range may be appreciated, let us turn for a moment to the Atlantic seaboard. Here the entire series of post-Jurassic rocks constitutes a comparatively thin veneer upon a coastal plain that nowhere rises more than a few hundred feet above the sea. The sediments are in large part unconsolidated, are practically horizontal, and are exposed only in the low banks of streams that flow sluggishly across the plain from the crystalline piedmont belt to the sea. On the Pacific coast, on the other hand, rocks of the same age have a thickness that may easily exceed 40,000 feet, have been deposited under conditions involving repeated vertical oscillations of the land measurable in thousands of feet, and have been folded and faulted into mountain ridges now standing thousands of feet above the ocean. Most significant of all is the fact, already brought out but presently to be further emphasized, that this extraordinary geological activity has continued up to the very dawn of the human era and is probably still in operation.

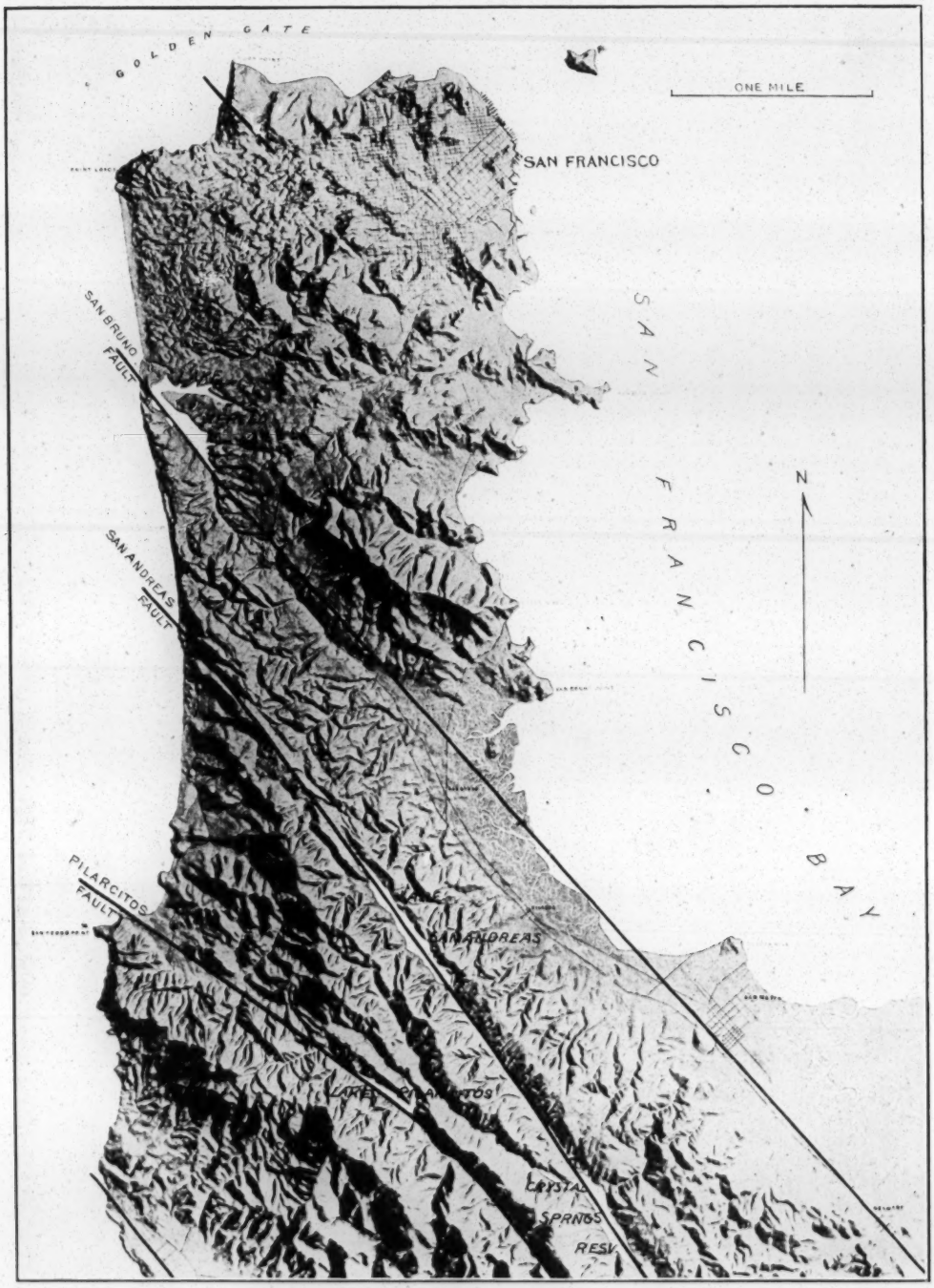
"FAULTING"

If any one will look at a good map of California he can scarcely fail to notice the striking parallelism of structure shown by that part of the state lying north of

Tulare Lake and south of Red Bluff, near the head of the Sacramento Valley. This parallelism is not confined to the two main ranges, the Great Valley and the coast line, but is conspicuously shown by the ridges and valleys of the Coast Range. In the absence of local geological knowledge, this feature of the topography might be ascribed to regular folding, such as that of the Appalachians. The actual complexity of the folding, however, and the fact that the structural details of the ridges show little accord with the general topographic regularity referred to, dispose effectually of this suggestion. There can be little doubt that the principal longitudinal ridges and valleys of the Coast Range are due to faulting modified by erosion. Much detailed work remains to be done before the positions and throws of all these faults can be determined, but such careful structural studies as have been made of definite areas have invariably revealed the great importance of dislocations having a generally north-northwest trend. This is particularly true of the San Francisco peninsula, which, as Prof. Lawson has shown, is traversed by at least three great faults belonging to this dominant system. These have been plotted on the accompanying outline map of the region about San Francisco Bay and relief map of the peninsula. The San Bruno fault has a throw of at least 7,000 feet near San Francisco, the southwest side having dropped relative to the northeast side. In all probability this same fault determines the positions of Bolinas and Tomales bays, north of the Golden Gate, and the straightness of the coast line as far as Point Arena, 100 miles northwest of San Francisco. Toward the south the same fault, or one belonging to the same zone, is said to be traceable almost to the Gulf of California, and in parts of southern California is locally known as "the earthquake crack." The San Andreas fault, which, as may be seen from the San Mateo topographic atlas sheet of the U. S. Geological Survey as well as from the small relief map on page 287, is followed by a rectilinear ravine occupied by a chain of ponds and lakelets whose existence is proof of recent disturbance. The third, or Pilarcitos, fault has not impressed its presence upon the topography of the peninsula in as conspicuous a manner as the other two. It is highly probable that future careful work will discover other great faults generally parallel with those mentioned. There is a strong suggestion, for example, of a fault passing near San José, along the eastern margin of the bay, through Santa Rosa, and northwestward along the valley of the Russian River past Ukiah.

THE COAST IS STILL RISING

There is still another series of movements undergone by this remarkable coast in late geological time, and these, like the faulting, are still in progress. Professor Lawson has clearly demonstrated that the coast of California has been elevated since the Pliocene to heights ranging from 1,500 feet near San Diego to over 2,000 feet in northern California. This uplift is shown with great clearness along the coast in the vicinity of Los Angeles by conspicuous wave-cut terraces, rising tier after tier above the present strand and showing all the characteristics of marine shores, even to pits made by the same species of rock-boring mollusc that inhabits the present beaches. These movements have not been uniform along the entire coast. For instance, the mainland at San Pedro south of Los Angeles has risen 1,240 feet, and San Clemente Island, 50 miles farther south, has risen 1,500 feet. Half way between these two localities is Santa Catalina Island, which not only shows no evidence of recent elevation but is clearly undergoing submergence. One of the latest phases of this vertical oscillation of the shoreline has been the submergence of the coast in the vicinity of San Francisco, whereby the depression now occupied by San Francisco Bay was transformed from a valley to one of the finest harbors in the world, and the Golden Gate, once a river gorge, was prepared for the part



Map of the San Francisco Peninsula

From the model by Prof. A. C. Lawson, of the University of California. The principal faults are indicated by heavy black lines

Photo by Bailey Willis

Coast of California about 55 Miles Southeast of Monterey

This part of the coast is a great fault scarp

Photo by Bailey Willis

Curious Pillow Structure in Basalt forming part of the Franciscan Series at Point Bonita, on the north side of the Golden Gate

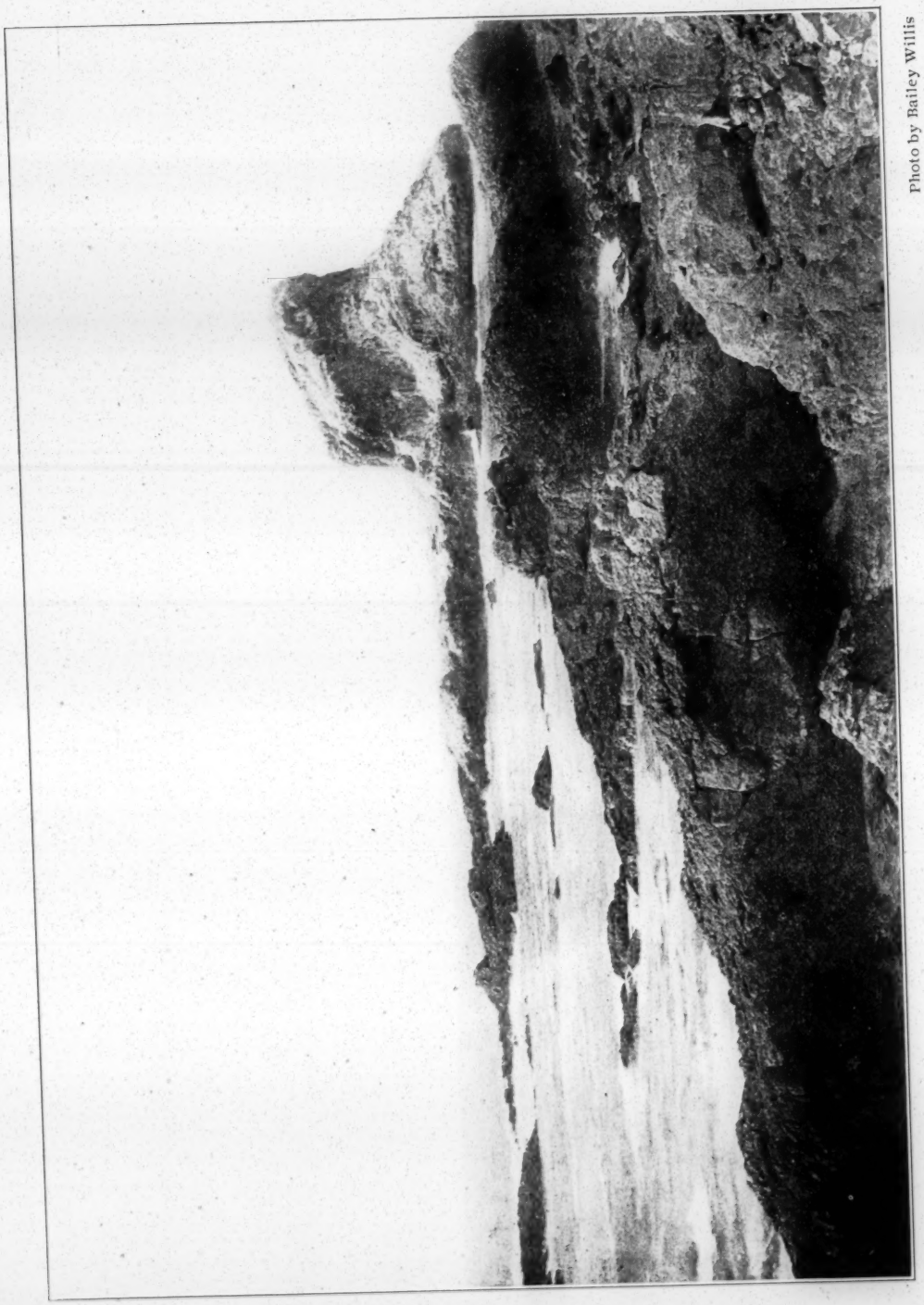


Photo by Bailey Willis

An Outcrop of Miocene Strata on the Coast of California near San Simeon

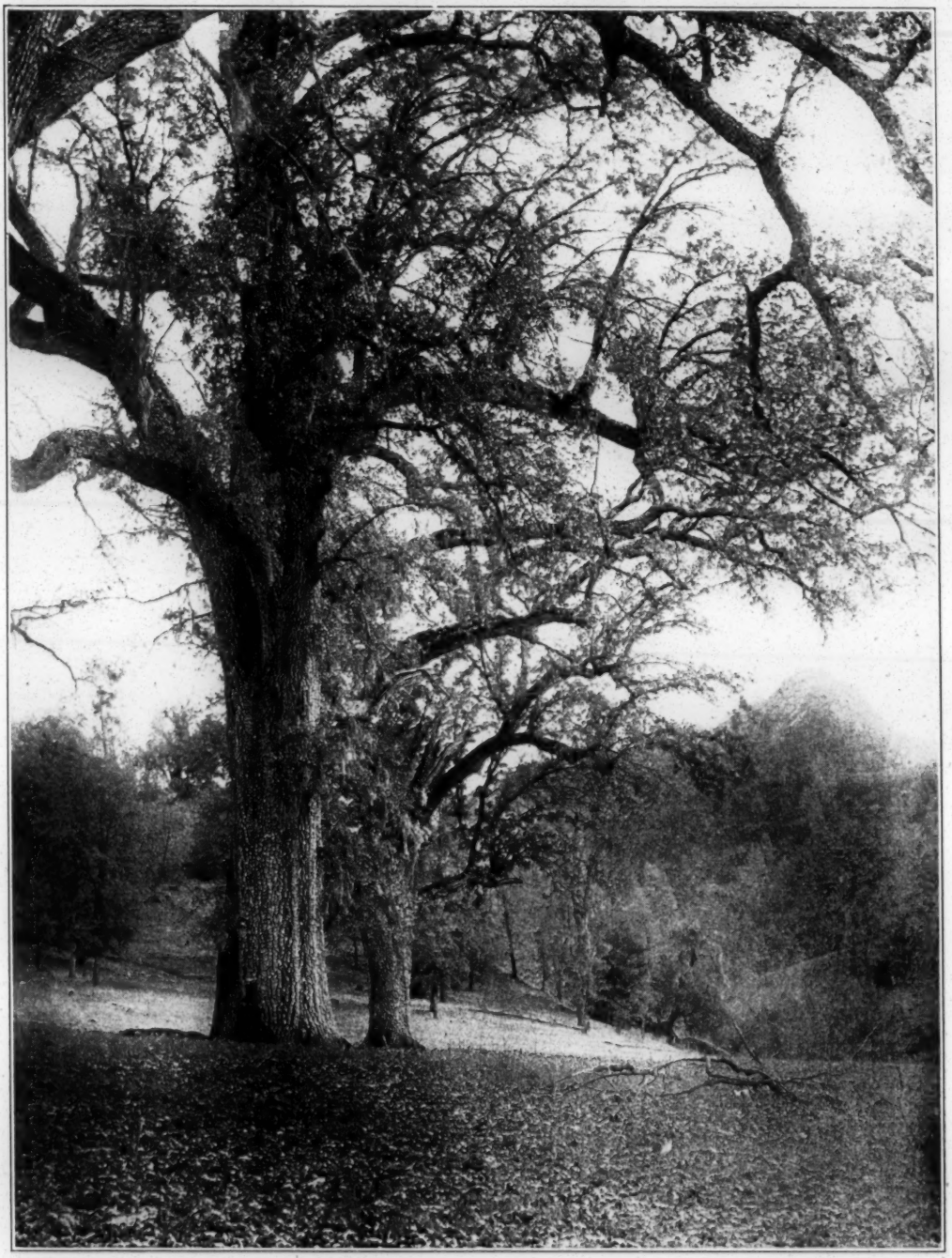
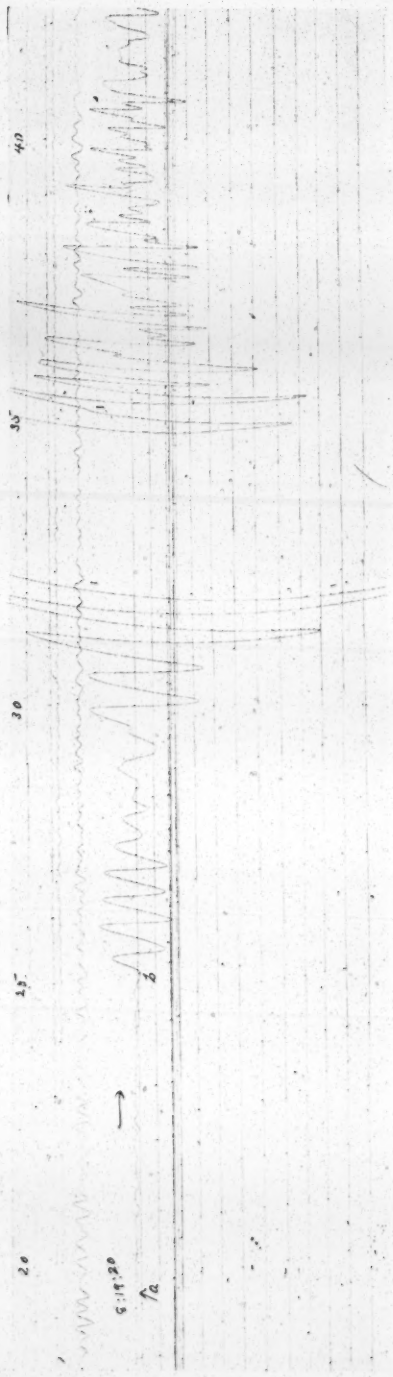


Photo by Bailey Willis

White Oaks on Piajo Creek, a branch of Naciemento Creek

Typical primeval vegetation of the fertile valleys of the Coast Range southeast of Monterey



Record of San Francisco Earthquake as made by the Seismograph at the U. S. Weather Bureau, Washington, D. C.

East and west component. Numbers at top are minutes of time corresponding to the dots on the record. (See page 296)

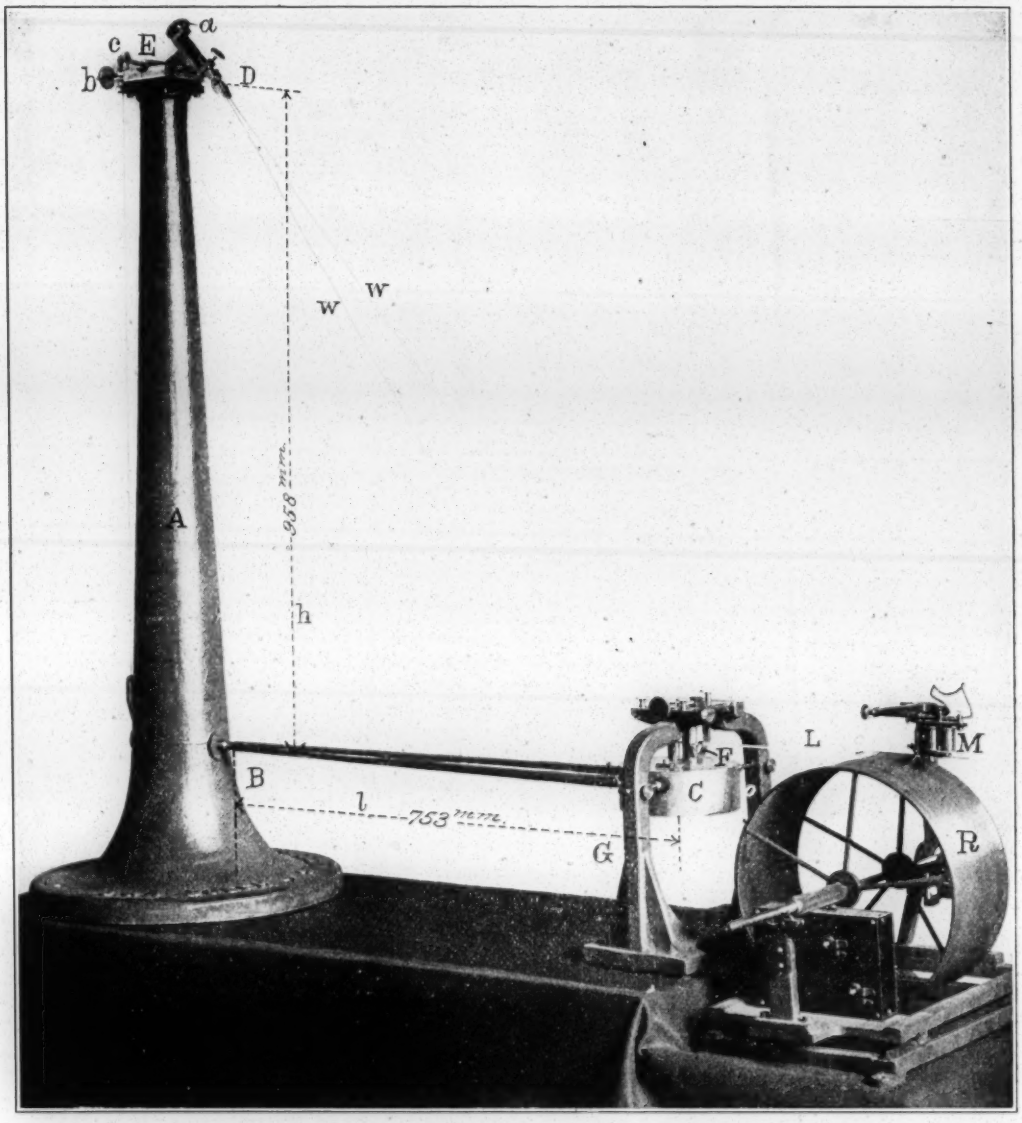
it was destined to play in the commercial development of the Pacific and the Orient.

PROBABLY IN NO PART OF THE WORLD HAS THE LAND BEEN SO ACTIVE IN RECENT TIMES

The general connection between the geological history that has just been briefly summarized and the earthquakes so prevalent in California is clear and unmistakable. We have seen that the record of the rocks shows that through long geological periods the land has oscillated up and down in a startling manner. Probably in no part of the world have the processes of upheaval and subsidence, folding and faulting, and erosion and sedimentation been, as a whole, so intensely active in the same period of later geological time. Moreover, the general activity and rapidity of geomorphic development have continued up to the present day. The region thus amply fulfills the conditions under which tectonic earthquakes arise. It is in unstable equilibrium, and it is cut by long north-northwest faults into narrow blocks which are in turn traversed by many minor dislocations. Under the operation of the unknown forces of elevation and subsidence, stresses are set up which finally overcome the adhesion of the opposing walls of one or more of the fault fissures, an abrupt slip of a few inches or a few feet takes place, and an earthquake results. The region extending for some hundreds of miles north and south of the Bay of San Francisco may be considered as particularly susceptible to shocks on account of the number and magnitude of the faults, the evidence that these furnish of very recent slipping, and the marked recent subsidence in the vicinity of the Golden Gate. We may now turn from the geological record to the recent disaster.

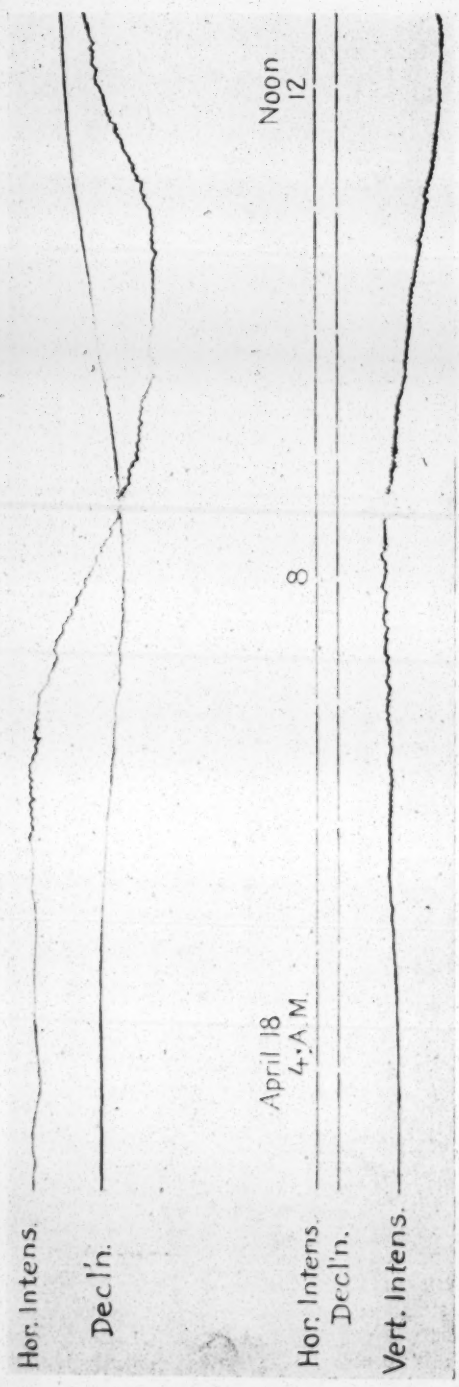
SUMMARY OF DAMAGE

The apparent facts with reference to the San Francisco earthquake of April 18, 1906, as gleaned from the daily papers, are as follows:



The Seismograph of the U. S. Weather Bureau

At 5:13 a. m., Pacific time, the city was violently shaken for 28 seconds. The force of the shock, as in 1868, was greatest in that part of the city built on made or alluvial ground (and probably heaved by epifocal waves) and was sufficient to completely wreck many large buildings and to seriously damage most of the structures in the business section. Water mains and sewers were broken, car tracks were twisted, and at Eighteenth and Valencia streets, not far from the old Spanish mission, a crevice 6 feet wide is reported to have opened in the ground. At several points in the lower portions of the city the ground is said to have set-



The San Francisco Earthquake of April 18, 1906, as recorded on the Magnetograph at the U. S. Coast and Geodetic Survey Magnetic Observatory at Cheltenham, Maryland. (See page 298)

tled several feet. A second strong but shorter shock was felt about three hours later, but as a vast conflagration was already sweeping the city the damage done by this after-quake was apparently not recorded. The city hall, situated a mile and a half from the east water front, was ruined, although it seems to have been the last building in this direction to receive serious injury.

Outside of San Francisco the principal damage is reported from a strip of country extending from the town of Ukiah, on the Russian River, 125 miles north of San Francisco, to the town of Salinas, near Monterey Bay, 80 miles south of the ruined metropolis. North and south of these limits, however, the country is for some distance sparsely settled and may have been vigorously shaken without the fact being reported. The belt of maximum disturbance is approximately parallel with the great faults of the region and includes the Bay of San Francisco and the rich Russian River, Sonoma, Santa Clara, Salinas, and San Benito valleys. Santa Rosa, the principal town of Sonoma County, was practically destroyed, and the smaller towns of Healdsburg, Cloverdale, and Ukiah to the north were badly damaged. Oakland, on the east side of the bay opposite San Francisco, apparently suffered some destruction in its business section, but, being mainly a city of frame dwellings, it escaped general demolition. The shock on this shore of the bay, however, was apparently heavy. The ground is said to have opened in some places, although the long moles of the Southern Pacific Company, built out into the bay by filling, seem strangely enough to have been uninjured. Many important buildings in Berkeley were destroyed, but the buildings of the University of California, standing on high ground, escaped. On the north shore of Suisun Bay part of the track of the Southern Pacific, laid on marsh, subsided several feet. A similar subsidence is reported from Alviso, a town at the south end of San Francisco Bay. The Santa Clara Valley suffered

severely, the principal buildings at Stanford University being destroyed or badly injured and San José being partly ruined. It is noteworthy, as indicating the narrowness of the general zone of destruction, that the Lick Observatory, situated on Mount Hamilton, about 15 miles east of San José, was uninjured. The district drained by the Pajaro River, between the town of Hollister and Monterey Bay, was much disturbed. The railroad for distances up to a mile was depressed from 4 to 6 feet. Between Castroville and Monterey the ground is said to have opened and shut and mud to have spurted from the fissures.

In the immediate vicinity of the coast comparatively little damage is reported, although the lighthouse at Point Arena, which, as already noted, is on the line of the San Bruno fault, was destroyed.

THE EARTHQUAKE ZONE

The general zone of destruction corresponds very closely to that of most of the earthquakes of central California. With the exception of the Vacaville earthquake in 1892, which was most severely felt in a belt stretching from San Francisco northeasterly through the opening in the Coast Range near Martinez and across the Great Valley to the lower slopes of the Sierra Nevada, most of the severe shocks have manifested themselves along the zone stretching from Ukiah to Hollister and Salinas. In other words, their major effects are confined to a zone at least 200 miles in length and approximately 30 miles in width. The distribution of intensities along this zone, as illustrated by the destructive effects at San José and at Santa Rosa, points decidedly to the initiation of the disturbance from a line or plane rather than from a point or definite centrum. Furthermore, the general parallelism of this line or plane with the great faults of the region can, in the light of geological history, scarcely be considered a mere coincidence. In short, the conclusion that the recent San Francisco earthquake, like those which have previously shaken the city, was of tectonic origin and that it was due to movement along one or more of the great faults may be regarded as reasonably certain. Whether this movement was along the San Bruno fault or along some other dislocation yet to be traced by patient geological work, cannot be determined from the crude and meager data now available. The reported destruction of the Point Arena lighthouse suggests that the San Bruno fault may have participated in the disturbance. If so, careful observation and comparisons of levels in the vicinity of San Francisco Bay may discover the extent of the movement.

EXPLANATION OF ABSENCE OF TIDAL WAVES

It is very probable that faults parallel with those known on land traverse the sea bottom along the coast. If any considerable throw has taken place along such a submerged fault, we may expect to receive indication of the event in a disturbance of the tidal records. Although in 1856, after a severe shock, lasting 8 seconds, the waters of San Francicso Bay are said to have risen, to have maintained their level for 5 minutes, and then to have fallen 2 feet below their ordinary stage, noticeable "tidal waves" do not appear to be characteristic of the earthquakes in California, and this fact indicates either that the shocks originate in the land area or else that they are caused by displacements of slight throw.

That San Francisco will rise beautiful and triumphant from ruin no one who knows California can doubt. Earthquakes are a risk that will be accepted by the people in the future with as little hesitation as in the past. They had grown a little careless and were taken unawares by the fatal combination of circumstances that made fire a more ruthless enemy than earthquake. Shocks will visit the new city, but they will shake buildings better able to resist them and less combustible. Professor Holden, writing in 1896, remarked that "the earthquakes of a whole century in California have been

less destructive than the tornadoes or the floods of a single year in less favored regions." While this statement may no longer be strictly true, it represents a feeling so general among Californians that no single disaster can eradicate it. Although there is every geological reason for expecting earthquake shocks in the future, there is no reason why, with properly constructed buildings and with adequate arrangements for extinguishing fires with supplies of salt water not dependent upon the ordinary mains, property and life should not be as safe in San Francisco as in any other city in the country.

THE RECORD OF THE GREAT EARTHQUAKE WRITTEN IN WASHINGTON BY THE SEISMOGRAPH OF THE U. S. WEATHER BUREAU

By C. F. Marvin

Professor of Meteorology, U. S. Weather Bureau

THE vast calamity wrought by the recent great earthquake at San Francisco amounts, it seems, to little less than the complete destruction of a great city. In a moment, almost, nearly its whole population of over 300,000 people are rendered homeless and helpless, and the sympathy and concern of the whole world is aroused in their welfare. These great human interests command the primary attention of all, but many readers will doubtless be interested to follow the simple and short account here given of some things concerning earthquakes and their measurement that modern science has accomplished.

Nowadays, by the aid of seismographs of almost inconceivable delicacy, a great earthquake occurring at one point on the globe is very certain to be recorded at practically every other point at which there is a suitable instrument. In the present case the vast expenditure of energy at San Francisco and its immediate vicinity literally set the entire mass of the earth into appreciable vibrations that subsided only after the lapse of several hours. Reports showing this to have been the case have already been announced from many places, such as Alaska, England, Italy, Austria, and islands of the Pacific. Records must certainly have been obtained throughout Europe, Asia, and Japan. Swifter than the telegraph could flash its messages of disaster throughout civilized Christendom, the trembling crust of the earth propagated its vibrations in every direction at great velocities and set the delicate registers of seismographs at work to write automatically their mute story of what was going on.

All the principal features of one of these records written at the Weather Bureau in Washington, D. C., is shown on page 292. The original record is inscribed mechanically by a sharp needle point, which traces a line upon a smooth surface of paper coated with a thin layer of soot. The numerous straight lines across the lower portion of the present record are the traces made during successive hours preceding the earthquake and show no motion of the ground. It is generally considered that a great earthquake like this at San Francisco is caused by a sudden break or fault in the strata forming the crust of the earth. Exceedingly complex vibrations, both great and small, immediately begin to radiate in every direction from the origin. The very first evidence of tremors that reached Washing-

ton appear at *a* on the record. These are the so-called preliminary tremors, which, either because they traveled faster or along a shorter path—perhaps for both reasons—reached Washington not less than six minutes earlier than the stronger motion, the record of which begins at *b*. About seven minutes later the needle was deflected off the record sheet by still more violent motion, but returned again at 8:35, and thereafter recorded vibrations of continually diminishing force for about four hours.

SPEED OF PROPAGATION

In the study of earth vibrations several distinct classes of waves are recognized, such as longitudinal, transverse, surface waves, distortional waves, etc. These appear to travel along different paths and at different velocities, and a full statement of the question of the speed of propagation is very complex. In a general way, however, it may be said that the so-called preliminary tremors travel by the shortest path between points—that is, *through* the earth along the chord rather than along the surface of the sphere. In the present case the great circle distance from San Francisco to Washington is about 2,435 miles, whereas the distance through the crust is about 40 miles shorter, and the straight-line path cuts below the surface of the earth about 186 miles at its deepest point. At still greater distances from San Francisco than Washington it is plain that the straight-line path cuts still deeper and deeper below the surface, and is also proportionately shorter and shorter than distances on the surface. Furthermore, because of its greater density and the enormous superincumbent pressure, the elastic properties of the deep-lying substance of the earth seems to propagate vibrations with higher and higher velocities the deeper the path. These considerations lead to the conclusion that if earthquake vibrations follow the path of the chord the speed of propagation should not be constant for all distances from the origin, but should be greater the greater the distance from the origin. This has generally been found to be true in the case of the preliminary tremors, and will doubtless be shown in this earthquake when accurate reports from numerous stations are examined. From San Francisco to Washington the speed along the chord is found to be 5.4 miles (8.7 kilometers) per second. This is based on Professor Davidson's time at San Francisco, viz, 5:12 a. m. This result is perhaps a trifle faster than we might expect.

The strong waves do not seem to follow the path of the chord, but rather travel along the surface at a slower rate, which is nearly constant for all distances. In the present case the velocity is 3.1 miles per second for the first strong waves, or as low as 2.2 miles per second for the maximum waves. Both of these speeds, however, are a little high, perhaps.

AMPLITUDE AND PERIOD OF THE WAVES

The recording needle of the seismograph traces a ten-fold magnification of the movement of the earth. On this basis the actual maximum displacement of the ground at Washington was nearly one-half inch each side of its position of rest. This may seem an astonishingly large movement, especially in view of the fact that no one felt any motion whatsoever. The explanation, however, is found in the fact that the motion is very slow and without shock, so that buildings and objects are moved to and fro without the slightest strain or injury.

THE SEISMOGRAPH

The record at Washington was made by the aid of the instrument shown on page 293. The massive lead weight *C* is suspended by the wires *W* and the horizontal strut so as to swing very freely about a nearly vertical axis from *D* to *B*. During an earthquake this heavy mass remains almost completely at rest with respect to lateral motions, and thus provides a steady point in reference to which the motion of the ground can be measured and registered. For this purpose a

long needle or lever, *L*, is pivoted very delicately to the heavy yoke piece *G*, secured to the ground. The short end of the lever rests very gently against a projection from the steady mass *C*. The long end is tipped with a light stylus, which writes the record on the smoked surface of the drum *R*. The magnet *M* serves, by the aid of a clock, to mark minutes of time on the record sheet.

THE SAN FRANCISCO EARTHQUAKE OF APRIL 18, 1906, AS RECORDED BY THE COAST AND GEODETIC SURVEY MAGNETIC OBSERVATORIES*

BY L. A. BAUER AND J. E. BURBANK

THE recent severe earthquake, which caused such serious damage in San Francisco and vicinity, was recorded on the seismograph at the principal magnetic observatory of the United States Coast and Geodetic Survey at Cheltenham, Maryland, 16 miles southeast of Washington, as the largest earthquake recorded since the instrument was mounted, in December, 1904. This observatory is 2,450 miles in an air line from San Francisco.

The seismograph is of the Bosch-Omori type, especially adapted to detect and record any vibration of the ground. It consists of two parts, one adjustable to record the north-south component of the earth's motion and the other adjusted to record the east-west component.

At Cheltenham (see table) the preliminary tremors began at 8h. 19m. 24s. at a distance of 2,450 miles from San Francisco. Assuming now the time of the first shock as 5h. 12m. 38s. Pacific time, or 8h. 12m. 38s. Eastern time, as given by Prof. A. O. Leuschner, of the University of California, the velocity of these tremors, along the chord† connecting San Francisco and Cheltenham, is found to be 5.9 miles, or 9.6 kilometers, per second, about 30 times the velocity of sound. The time taken for these waves to cross the continent was 6 minutes 46 seconds. The large waves began about 8h. 30m. 13s., or at an interval of 17m. 35s. after the first shock was felt at San Francisco; hence the velocity of these waves appears to be about 2.32 miles per second.

As will be seen from the accompanying table (I), the duration at Cheltenham of the earthquake was about 4 hours. The duration of the strongest motion, however, was only from 8h. 30m. to about 8h. 40m.; during this period the amplitude of the motion was too large to be wholly recorded by the seismograph.

The period of vibration in the preliminary tremors was about two to four seconds; in the principal portion it varied from ten to twenty seconds.

†It is a mooted question as to the precise path followed by the preliminary tremors; it is believed, however, that the distance traversed will correspond much more nearly to that of the chord than to that along the surface. According to the distinguished seismologist, Prof. E. Wiechert, director of the Geophysical Institute at Göttingen, Germany, who is making at present a brief visit in the United States and to whom was shown the records obtained by the Coast and Geodetic Survey, the large disturbances, traveling much less rapidly than the preliminary tremors, proceed most likely along the surface or at least at no very great depth below it.

* Communicated by Mr O. H. Tittmann, Superintendent of the U. S. Coast and Geodetic Survey.

The corresponding data as communicated in a cable dispatch from the Sitka magnetic observatory will be found in the tables below.

The air-line distance of Sitka from San Francisco is 1,455 miles, whereas the distance along the chord is about 1,447 miles. Accepting the time of the first shock felt at San Francisco as given above by Professor Leuschner, it took 4 minutes 18 seconds for the preliminary tremors to reach Sitka, against 6 minutes 46 seconds to reach Cheltenham. The velocity along the chord connecting Sitka and San Francisco is 5.6 miles, or 9.0 kilometers; hence about the same as that deduced for the corresponding waves at Cheltenham.

The present indications are that the source of the earthquake disturbance was not far from San Francisco, though more definite information on this point will be had as soon as the records from the Honolulu observatory have been received.

According to Professor Leuschner, quoted above, who had in operation during the earthquake a Ewing seismograph, the principal direction of motion was S.SE. to N.NW. He says that "the remarkable feature of this earthquake, aside from its intensity, was its rotary motion." Comparing the three severest earthquakes on record at San Francisco, viz, those of October 21, 1868, March 30, 1898, and the present one, he finds that they have several features in common, namely, that the heaviest shocks are generally in the direction S.SE. to N.NW.; and, again, while the displacements are very large, the vibration period is comparatively slow, amounting to about one second in the last two big earthquakes. He says "the slowness of the vibration is the only redeeming feature of these calamities."

This earthquake, besides being recorded the world over on seismographs, likewise affected the self-recording magnetographs at the three magnetic observatories of the Coast and Geodetic Survey thus far heard from.

At the magnetic observatory, Cheltenham, Maryland, the disturbance began about 8:30 a. m., Eastern time, on April 18, and continued for about half an hour. It will be noticed in the table giving the time as recorded by the seismograph that while this disturbance began some time later than the preliminary tremors, it coincides with the principal portion of the disturbance as recorded on the seismograph. It affected principally the horizontal and vertical components of the earth's magnetic intensity; the greatest disturbance amounts to one-one-thousandth part of the horizontal intensity and about one-two-thousandth part of the vertical intensity. It was not of the same character as that due to a cosmic magnetic storm or as that recorded in connection with the Mont Pelé eruption, but appears to be chiefly, if not entirely, mechanical.

[At the present moment it cannot be definitely stated whether there was a general magnetic disturbance similar to that of the Mont Pelé eruption in connection with the recent eruptions of Vesuvius. A very similar disturbance began on April 8 at 9h. 39m. a. m., Eastern time. However, this is 12 hours later than the reported time of the beginning of the Vesuvius eruption. It will be necessary to await the full reports from Professor Matteuci's Vesuvius observatory. Magnetic disturbances affecting simultaneously points over the entire earth do not necessarily accompany volcanic eruptions. For example, the mighty eruption of Krakatoa was not accompanied by a magnetic disturbance of the character associated with the Mont Pelé eruption; its effect on magnetic instruments was local.]

The illustration on page 294 shows the earthquake disturbance as recorded on the magnetograph at the Cheltenham observatory.

At Baldwin, Kansas, where there is no seismograph, the magnetic instruments also recorded a similar disturbance, lasting from 8:24 to 8:31, Eastern time, some time after the preliminary tremors of the earthquake had reached Cheltenham. At

this observatory also some preliminary effects were noted.

At the Sitka observatory this disturbance was also recorded by the magnetic instruments from 8:24 to 8:30, Eastern time, somewhat later than the preliminary tremors recorded on the seismograph at the same observatory.

It is of interest to point out that the times recorded for the principal disturbances at the latter two places, Baldwin and Sitka, which happen to be nearly the same distances from San Francisco, are about the same. Furthermore, it is seen that the disturbance at Cheltenham (see Table II) begins at a proportionate interval later.

It is to be noticed that in each of the three cases the disturbance on the magnetograph occurs at about the same time that the greatest motion is being recorded on the seismograph.

The self-recording magnetic instruments, or magnetographs, on which the above-described effects were recorded, consist of very small magnets about one inch long and a third of an inch wide by one-sixtieth of an inch thick, suspended by a fine quartz fiber and carrying a tiny mirror. The record is obtained by reflecting a spot of light from the mirror to a sheet of sensitive photographic paper wound on a cylinder, the latter being revolved uniformly by means of a clockwork. By this means a continuous record of the movements of the magnets is obtained on the paper. Two of these magnets, each mounted at some distance from the other, record respectively the declination or direction and the horizontal component of the earth's magnetic intensity. A third magnet, somewhat larger, mounted on sharp points and moving in a vertical plane, records the vertical intensity of the earth's magnetic force.

The question whether the earthquake disturbs the magnets in a purely mechanical way or by its action on the earth's magnetism is by no means settled. In fact it is only recently that this phenomenon is being systematically studied. Up to the present the results are contradictory. At times the magnetic disturbance is simultaneous with or actually precedes the preliminary tremors. In other cases, like the present one, it accompanies the principal portion of the disturbance. In some cases of large earthquakes no magnetic effect can be detected, and in a few other cases, notably March 21, 1904 (New England earthquake), the shock was recorded at Cheltenham by the magnetic instruments, but was not recorded by the seismographs at Toronto, Baltimore, or Washington.

TABLE I

SAN FRANCISCO EARTHQUAKE OF APRIL 18, 1906, AS RECORDED BY THE SEISMOGRAPHS OF THE U. S. COAST AND GEODETIC SURVEY AT SITKA, ALASKA, AND CHELTENHAM, MARYLAND

(Eastern or 75th meridian time)

	Sitka, Alaska.	Cheltenham, Maryland.
	h. m. s.	h. m. s.
Preliminary tremors began	8 16 56	8 19 24
Principal disturbance at	8 20 48	8 30 13
Maximum disturbance, about	8 23	8 35
Disturbance ended about	10 57	12 00

TABLE II

AS RECORDED ON THE MAGNETOGRAPHS

(Eastern or 75th meridian time)

	h. m.	h. m.
Sitka Alaska	8. 24 to 8	30 a. m.
Baldwin, Kansas	8 24 to 8	31 a. m.
Cheltenham, Maryland	8 30 to 9	04 a. m.

U. S. Coast and Geodetic Survey,
April 20, 1906.

The Republic of Chili. By Marie Robinson Wright. Pp. 450, with many illustrations. 9½ x 12½ inches. Philadelphia: Geo. Barrie & Sons. 1904.

This book is dedicated "To the women of Chile," which republic, we are told, is as nearly a woman's paradise as any country outside of the United States can be. Little of the seclusion enforced by many Latin races is found here, and the Chilean woman holds a high place in the social and domestic economy of the country.

The wealthy Chilean lives principally at his country home. Thousands of acres of land often comprise these estates, and in many cases it becomes necessary to establish sawmills, blacksmith shops, and refrigerating plants, as well as farms, for the private use of their owner. A most attractive picture of social and domestic life on these plantations is given in a chapter, "Life on a Chilean Hacienda."

In contrast to these luxuriant estates is the arid "nitrate desert," where nothing can be grown except by artificial means, and such plants as ornament Iquique are raised in soil brought from distant parts of the country. Water is brought to the city from an oasis a hundred miles away. These fields are, however, Chile's treasure-house, as she exports over a million tons of nitrate annually to Europe and the United States. F. M. A.

The Congo: a Report of the Commission of Inquiry. Pp. 171. New York and London: G. P. Putnam's Sons. 1906.

The above is a translation made by Prof. James H. Gore. In consequence of numerous reports of abuses practiced upon the natives of Congo Free State by officers of the government and by other persons, in 1904 the King of Belgium appointed a committee of three persons to investigate the conditions in that state, especially with reference to these charges, and to suggest suitable remedies for abuses, if any were found to exist. This committee commenced its investigation October 5, 1904, and closed it February 21, 1905, thus devoting four and one-half months to work on the ground. The investigation appears to have been thorough and impartial.

The commission found that many, if not most, of the charges were substantiated, but that a large proportion of the cases were unavoidable. If it was desirable, for the protection of the natives against the slave traffic and from internecene wars, not to mention their education and advancement in civilization, that a white man's government should be instituted over them, and presumably it was desirable, the natives must submit to taxation for its support. The tax takes the form of contributions of natural products or of labor. Now the average native, not appreciating the benefits of good government, endeavors to evade the payment of the tax, owing to his indolent disposition, and measures have to be taken to collect the tax, by force if necessary. Hence whipping and imprisonment have been resorted to, and in many instances conflicts have occurred in which the black soldiery have massacred the inhabitants of villages. Moreover, besides the labor received in working out taxes, much native labor must be had for railroad and station building and for a thousand other purposes connected with the institution and carrying on of government, which it is difficult, and in many cases impossible, to obtain without conscription.

Certain parts of the territory of the Congo Free State, moreover, have been farmed out to companies which are exploiting them, and it is in these concessions that the greatest abuses have been discovered, as might be expected.

The commission makes many recommendations for reform, and for the purpose of carrying these out the King of Belgium has appointed a committee of fourteen persons, including the three members of the committee on investigation. H. G.

Old Provence By Theodore A. Cook. 2 vols. Pp. 348, 448. 5 x 8 inches. Illustrated. New York: Scribner's. $4.00 *net.*

These two volumes from the pen of Theodore Cook will be thoroughly enjoyed by lovers of romantic and historical mysticisms, folklore, and legends of Old France, and especially will they be welcomed by many who read and appreciated the former volumes of Mr Cook, "Old Touraine," the Life and History of the Chateaux of the Loire.

In volume I Mr Cook has given much historical information of the Phœnician, Greek, and Roman rule in Old France, together with many illustrations and accurate descriptions of the architectural wonders created by them, many traces of which are yet to be found.

Coming down through the centuries, volume II contains a fund of information touching upon the religious beliefs and worship of the times, bringing out in relief the class distinction and the almost God-like reign of the feudal lords, together with the unceasing wars between the princes of the church.

Every page of this interesting history seems to furnish a romance in itself, and one readily discerns the historical field of Maurice Hewlett's romances. J. O. L.

The Philippine Experiences of an American Teacher. By William B. Freer. Pp. 344. 5 by 7¾ inches. Illustrated. New York: Charles Scribner's Sons. 1906.

In this volume we see the Filipino in his home, in his church, at some gay fiesta, and at the schools established by American teachers, who are frequently aided in their teaching by trained natives. The old method of "rapid-fire" questions used to instruct youth under the Spanish regime has been put aside for the newer system of giving instruction in English

through object and action lessons. The children take much interest in this mode of learning, and make good progress. Night schools have been established for grown people, and are well attended, for the Filipino child and adult are eager to learn.

A list of Spanish words and their English equivalents, a bibliography, and an index are found at the end of the book. F. M. A.

BOOKS ON ITALIAN SUBJECTS*

†"Italy, Rome, and Naples." Hippolyte Adolphe Taine. Henry Holt. $2.50.

†"Rambles in Naples." S. Russell Forbes. Thomas Nelson Sons. $1.25.

†"Naples:" The City of Parthenope. Clara Erskine Clement. Dana, Estes & Co. $3.00.

†"Southern Italy and Sicily, and the Rulers of the South." Francis Marion Crawford. Illustrated by one hundred original drawings by Henry Brokman. Macmillan Co. $2.50.

†"Italy and the Italians." Edward Hutton. E. P. Dutton. $1.50.

†"Cities of Southern Italy," "Cities of Central Italy," "Cities of Northern Italy." By Augustus Hare. Macmillan Co. $3.50.

†"Travels in Italy." By De Amicis.

"A Short History of Italy: An attempt to give a correct impression of Italian history as a whole." Henry Dwight Sedgwicke. Houghton, Mifflin & Co. $2.00.

†"Italian Cities." Edwin Howland Blashfield and Evangeline Wilbur Blashfield. Scribner. 2 volumes. $4.00.

†"Italian Byways." John Addington Symonds. Scribner. $4.20.

†"Two in Italy." Maud Howe. Little, Brown & Co. $2.00.

†"Roma Beata:" Letters from the Eternal City. Maud Howe. Little, Brown & Co. $2.50.

†"Ave Roma Immortalis:" Studies from the Chronicles of Rome. Francis Marion Crawford. Macmillan Co. $2.50.

"Walks in Rome." Augustus Hare.

†"The Eternal City of Rome:" Its religions, monuments, literature, and art. Clara Erskine Clement. Dana, Estes & Co. 2 volumes. $6.00.

†"Venetian Life." William Dean Howells. Houghton, Mifflin & Co. 2 volumes. $5.00.

†"Salve Venetia:" Gleanings from Venetian history. Francis Marion Crawford Macmillan Co. 2 volumes. $5.00.

*It is planned to publish each month a bibliography of good books on some current geographic subject.

†Illustrated.

UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C., *April* 23, 1906.

Editor National Geographic Magazine:

In your April issue there is a letter by Mr C. M. Taintor relative to glaciers in the Wind River Range, Wyoming, for which he proposes the name Roosevelt Glaciers. Without considering the desirability of the appellation, it should be pointed out that these glaciers were discovered in 1878 by Prof. W. H. Holmes, Director of the Bureau of Ethnology, when he was conducting one of the expeditions of the U. S. Geological Survey, under the direction of F. V. Hayden. Professor Holmes prepared a panorama of the principal glacier, which is included in the atlas accompanying the report of the Hayden Survey for 1878. Later he supplied descriptive notes which were incorporated in a memoir by I. C. Russell, on "Existing Glaciers in the United States," published in the 5th Annual Report of the U. S. Geological Survey, page 344.

Yours truly, N. H. DARTON,
Geologist.

ANNUAL EXCURSION OF THE NATIONAL GEOGRAPHIC SOCIETY

The annual excursion of the members of the National Geographic Society resident in Washington and vicinity will this year be to the noted Luray Caverns, in Page County, Virginia. The excursion will leave Washington on a special vestibule train from the Baltimore and Ohio depot, Saturday morning, May 19, at eight o'clock sharp, reaching Luray about eleven. Busses will carry the party to the caverns, situated about half a mile from the station, through which they will be escorted in parties by guides. After the excursion through the cave a substantial hot luncheon will be served at the Mansion Inn. Those who prefer can get their luncheon before visiting the cave. The party will take the train again about half past three, reaching Washington about six-thirty.

Through the courtesy of Mr S. B. Hege, district passenger agent of the Baltimore and Ohio Railroad, the National Geographic Society has been granted a special rate of $2.50 for the round-trip ticket to Luray. Transportation to the cave and back, admission fee, and luncheon will cost $1.50 additional; so that the total expense for the trip will be $4.00 for each person. (The regular round trip fare to Luray is $5.75 and admission to the caverns and bus fare $1.25, but the daily train schedule is such that a trip to the caverns cannot ordinarily be made with comfort for less than $10.00.) As the committee has been obliged to give a guarantee of 175 persons in order to secure these special rates, the request is made that every member who intends to take part in the excursion will send in his name immediately and the names of the friends accompanying him. The Luray Caverns are among the most wonderful natural phenomena in the world. They are not as large as the Mammoth Cave, but in brilliancy and beauty they are reputed to surpass it.

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